FINAL REPORT | MAY 31, 2014

MINNEAPOLIS CBD TRAFFIC FLOW IMPROVEMENT PROJECT

S.P. 141-080-46
CMAQ 2710 (118)

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Executive Summary

The following section provides a brief overview and highlights project benefits of the Minneapolis CBD Traffic Flow Improvement Project (Downtown Retiming Project) completed for the City of Minneapolis. The Downtown Retiming Project includes 205 traffic signal systems bounded by the Mississippi River, I-35W, I-94 and 6th Avenue N.

Project Funding

The City of Minneapolis (Minneapolis) received a $525,000 federal grant through the Congestion Mitigation and Air Quality program – CMAQ 2710(118), to improve traffic flow and reduce emissions within the Minneapolis Downtown CBD. The Downtown Retiming Project, completed in December 2013, is one part of the overall city wide retiming of traffic signal systems.

Project Objective and Purpose

The Downtown CBD was last fully retimed in the early 1990's. Since then, the Downtown has undergone significant changes in the way of infrastructure, development and traffic circulation patterns. Examples of these changes include the construction and operation of Northstar Commuter Rail, the Hiawatha LRT line, Target Field and surrounding street changes, conversion of Hennepin, 1st Avenue and 2nd Avenue to two-way traffic, redevelopment of the warehouse district, redevelopment of Downtown East, the Marquette and 2nd Avenue Transit improvements and the 4th Street contra flow bus lane. Over the years, Minneapolis has made localized timing adjustments and has developed special timing plans to accommodate the changes; however, a comprehensive review of the overall Downtown area has not been completed in nearly 20 years.

The objective of the Downtown Retiming project is to conduct a comprehensive review the existing conditions, improve crosswalk crossing times for pedestrians, optimize the signal system network, and to implement and fine-tune the new timing plans to actual traffic conditions. Consistent with the CMAQ funding requirements, specific goals of the project include:

1. Improve pedestrian crosswalk crossing times and update the signal controller timing parameters to be in accordance with the latest edition of Minnesota Manual on Uniform Traffic Control Devices (MMUTCD).
2. Improve bus transit operations and reduce route travel times to the extent feasible.
3. Improve light rail transit operations through reducing signal delay and progressing trains between stations without stops
4. Improve the overall intersection traffic signal efficiency by improving traffic flow progression and reducing delays, fuel consumption and emission output for motor vehicle movements.

Elements of Study

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of intersection and traffic volume characteristics, signal timing parameters, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness. The Synchro and SimTraffic models developed in evaluation of the existing conditions were used to create optimized signal timing plans. The traffic signal optimization included developing time of day coordination timing plans consisting of new cycle lengths and timing parameters for each of the signalized intersections.

A project benefit analysis is completed that determines how well the project goals are met by comparing key measures of effectiveness against the existing conditions. These key measures include vehicle delay, fuel consumption, vehicle stops, emissions and passenger and transit vehicle travel times. In addition, a benefit/cost analysis is completed to evaluate the overall cost-effectiveness of providing optimized traffic signal timing.

The results of the Downtown Retiming Project presented in the following sections of the report:

- Introduction (Section 1.0)
- Existing Conditions (Section 2.0)
- Signal Timing Optimization and Implementation (Section 3.0)
- Project Benefit Analysis (Section 4.0)

Project Conclusions

The following summarizes the expected project benefits with respect to the project goals:

Goal 1: Improve crosswalk crossing times for pedestrians and update timing parameters.

- A complete review of each local controller timing database was completed. New pedestrian clearance intervals, yellow change, all red clearance and minimum green intervals were implemented and are in accordance with the latest edition of the MMUTCD.
- Pedestrian crossing intervals were increased by an average 17 percent throughout the CBD.
- Other database reviews and updates included: intersection preemption parameters (where in operation), overlap clearance values, special sequence, access data and intersection startup values.

Goal 2: Improve bus transit operations and reduce route travel times to the extent feasible.

- The bus field studies found that the majority of bus corridor routes experienced a reduction in travel time. In total 32 routes were measured across the a.m., mid-day and p.m. peak periods, 22 of the routes were improved.

- The detailed VISSIM modeling completed for Marquette Avenue/2nd Avenue corridors found an estimated 6 percent and 2 percent reduction in signal delay during the a.m. and p.m. peak periods, respectively. As a result, an estimated reduction of 135 hours of passenger delay is expected.

Goal 3: Improve light rail transit operations through reducing signal delay and progressing trains between stations without stops.

- During the a.m. and p.m. peak periods, an LRT vehicle leaving a station at the start of bar signal can progress station to station in both directions between the Warehouse District and Downtown East stations. The outbound (southbound) train can progress station to station from Target Field to Downtown East during all timing plans.
- The VISSIM modeling completed for the LRT route found an expected 33 percent, 8 percent and 52 percent reduction in signal delay for the outbound (southbound) LRV during the a.m., mid-day and p.m. peak periods, respectively. A 26 percent, 15 percent and 18 percent reduction in signal delay was found for the inbound (northbound) LRV during the a.m., mid-day and p.m. peak periods, respectively. In total, the reduction in signal delay is expected to result in a reduction of 145 hours of passenger delay.
- The field data collected on board the LRV found a 5 percent reduction in overall travel time for the inbound (northbound) train throughout the day (approximately 30 seconds). The outbound (southbound) train was found to experience an 11 to 17 percent reduction in travel time (1 to 2 minutes) over the day.

Goal 4: Improve the overall intersection traffic signal efficiency by improving traffic flow progression and reducing delays, fuel consumption and emission output for motor vehicle movements.

- On a daily basis, the overall network performance found a 14 percent reduction in total vehicle delay, 8 percent reduction in fuel consumption, 7 percent reduction in emission output and a 19 percent reduction in total vehicle stops.
- The field travel time studies found that 60 percent of the blocks experienced a reduction in travel time (70 percent of all blocks were either unchanged or experienced a reduction in travel time).
- The travel time studies found an overall average reduction of 14 percent. On a route by route basis during the a.m., mid-day, p.m. peak periods the majority of routes experienced a reduction in travel time (46 of the 60 routes collected), with a few routes experiencing significant savings (i.e., eastbound Washington Avenue travel time reduced by 50 percent).

The optimized and implemented timing plans have met the project goals and have resulted in an overall traffic flow improvement throughout Downtown for motorists and transit as validated through both traffic modeling and field data validation. Considering

the overall Downtown network, the benefit analysis estimates the Downtown Retiming Project is expected to result in a one year 49:1 benefit to cost ratio, a three year 68:1 benefit to cost ratio, and an estimated annual economic savings of 25.9 million dollars. The project benefit includes an estimated 17 percent increase in pedestrian crossing time and estimated annual savings of 706,000 hours of delay, 850,000 gallons of gasoline and 71,000 kilograms of CO emissions.

1.0 Introduction

The City of Minneapolis Downtown CBD Retiming Project, completed in December 2013, is documented in this report and includes 205 traffic signal systems bounded by the Mississippi River, I-35W, I-94 and 6th Avenue N in the City of Minneapolis, Minnesota. The traffic signals included in the Downtown Retiming Project are illustrated on Figure 1.

1.1 Project Overview and Funding Sources

The City of Minneapolis (Minneapolis) has invested 11.7 million dollars into the rebuilding of their Central Traffic Management Center and to complete several traffic operation and infrastructure improvement projects throughout the city. Nearly 80 percent of the funding was received through the Congestion Mitigation and Air Quality federal grant program (CMAQ). The remainder of the funding is provided through Hennepin County, State and local funding sources. The project improvement breakdown includes:

1. Optimization of Traffic Signal Systems **($1,850,000).**
   - The city wide retiming is broken into three separate projects – Central Business District Traffic Flow Improvement (Downtown Retiming) - $525,000;
   - South Minneapolis Traffic Flow Improvement - $860,000; and
   - North/Northeast/Southeast Traffic Flow Improvement Project - $465,000.

2. Improvement of the Traffic Management System **($9,834,000).**
   - Rebuilding the Central Traffic Management Center (TMC) at Border Avenue;
   - Replacing 141 existing electromechanical controllers (EF-20) with state-of-the-art controllers, cabinet equipment and software; and
   - Deploying fiber optic cable and upgrading their traffic signal communication network citywide.

1.2 Background

The Downtown CBD was last fully retimed in the early 1990's. Since then, the Downtown has undergone significant changes in the way of infrastructure, development and traffic circulation patterns. Examples of these changes include the construction and operation of Northstar Commuter Rail, the Hiawatha LRT line, Target Field and surrounding street changes, conversion of Hennepin, 1st Avenue and 2nd Avenue to two-way traffic, redevelopment of the warehouse district, redevelopment of Downtown East, the Marquette and 2nd Avenue Transit improvements and the 4th Street contra flow bus lane. Over the years, Minneapolis has made localized timing adjustments and has developed special timing plans to accommodate the changes; however, a comprehensive review of the overall Downtown area has not been completed in nearly 20 years.

1.3 Study Objectives

The objective of the Downtown Retiming project is to conduct a comprehensive review of the existing conditions, optimize the signal system network, and to implement and fine-tune the new timing plans to actual traffic conditions. Specific goals of the project include:

1. Improve pedestrian crosswalk crossing times and update the signal controller timing parameters to be in accordance with the latest edition of Minnesota Manual on Uniform Traffic Control Devices (MMUTCD).
2. Improve bus transit operations and reduce route travel times to the extent feasible.
3. Improve light rail transit operations through reducing signal delay and progressing trains between stations without stops
4. Improve the overall intersection traffic signal efficiency by improving traffic flow progression and reducing delays, fuel consumption and emission output from motor vehicle movements.

1.4 Elements of Study

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of intersection and traffic volume characteristics, signal timing parameters, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness. The Synchro and SimTraffic models developed in evaluation of the existing conditions were used to create optimized signal timing plans. The traffic signal optimization included developing time of day coordination timing plans consisting of new cycle lengths and timing parameters for each of the signalized intersections.

A project benefit analysis is completed that determines how well the project goals are met by comparing key measures of effectiveness against the existing conditions. These key measures include vehicle delay, fuel consumption, vehicle stops, emissions and passenger and transit vehicle travel times. In addition, a benefit/cost analysis is completed to evaluate the overall cost-effectiveness of providing optimized traffic signal timing.

The results of the Downtown Retiming Project will be discussed in the following sections:

- Existing Conditions (Section 2.0)
- Signal Timing Optimization and Implementation (Section 3.0)
- Project Benefit Analysis (Section 4.0)

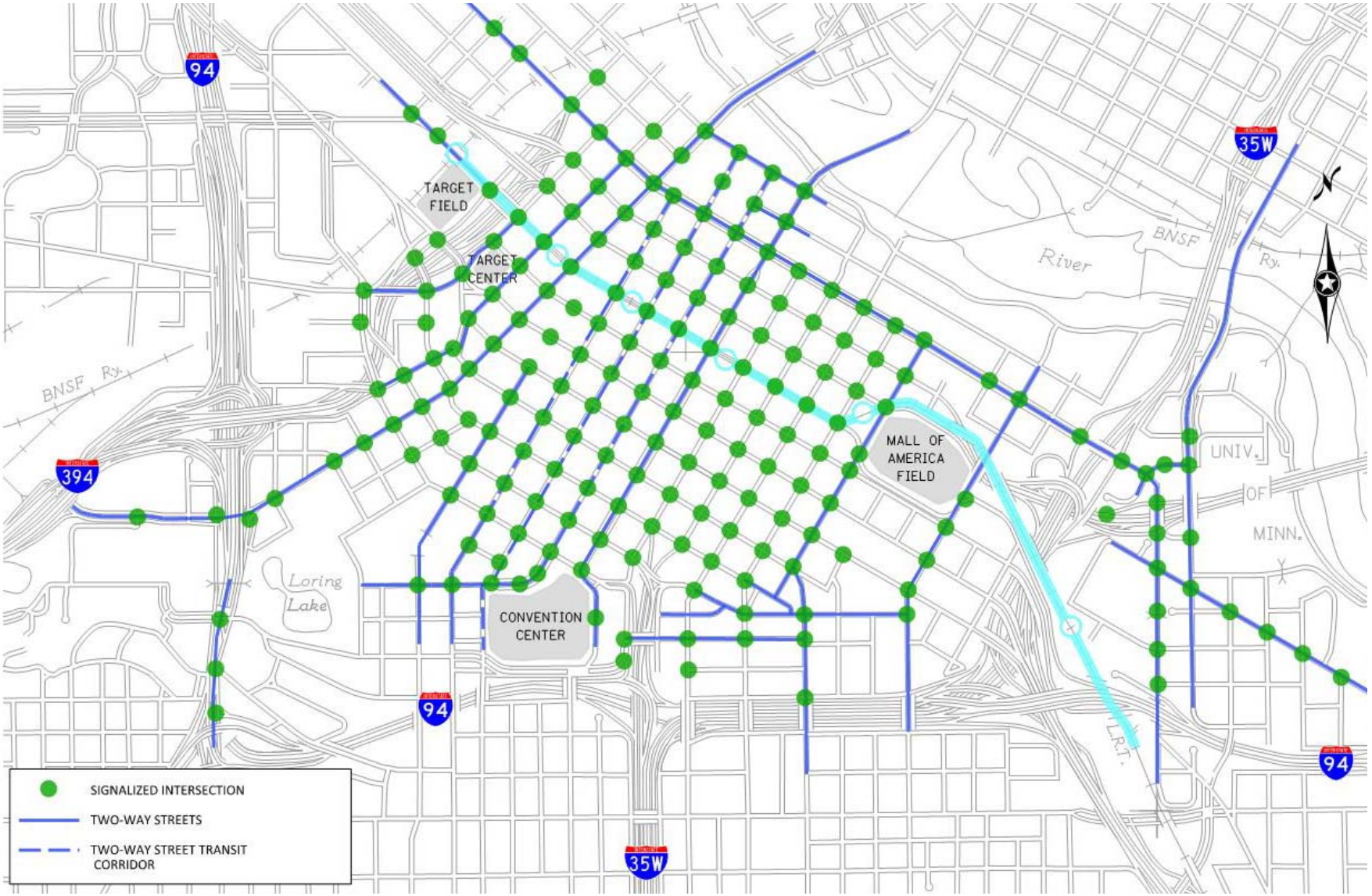


Figure 1. Project Area

2.0 Existing Conditions

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of corridor intersection and traffic volume characteristics, signal timing characteristics, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness.

2.1 Existing Roadway, Traffic and Transit Characteristics

The following sections document the key characteristics of the existing conditions.

2.1.1 Lane Geometries, Signal Phasing, and Signal Timing

Existing traffic signal timings and the T2000/Fastracs database for each intersection were obtained from the City of Minneapolis. Key parameters include; minimum green times, clearance intervals, pedestrian intervals and coordination data (cycle length, offset, splits) and time of day (TOD) settings. Signal phasing information was obtained through the T2000 database log files and intersection field reviews. Figure 2 illustrates the location of left turn arrows and type of operation. Google Earth and field reviews of each of the intersections were conducted to confirm lane geometrics, on-street parking or curb uses and restrictions by time of day, crosswalk distances, as well as storage lengths for turn bays.

Figure 3 illustrates the existing cycle lengths in operation by timing plan and Table 1 summarizes the existing timing plan daily schedule.

Table 1. Existing Timing Plan Schedule

CBD

Day	Operation	Time	Timing Plan	Note
Weekday	TOD	Midnight to 600 AM	Off Peak	(1)
		600 AM to 845 AM	AM Peak	(1)
		845 AM to 300 PM	Off Peak	(1)
		300 PM to 630 PM	PM Peak	(1)
		630 PM to Midnight	Off Peak	(1)

(1) See Cycle Length Map

Lyndale/Hennepin Avenue Commons Area

Day	Operation	Time	Timing Plan	Note
Weekday	TOD	Midnight to 630 AM	Off Peak Low	(1)
		630 AM to 900 AM	AM Peak	(1)
		900 AM to 300 PM	Off Peak High	(1)
		300 PM to 630 PM	PM Peak	(1)
		630 PM to Midnight	Off Peak Low	(1)

(1) See Cycle Length Map

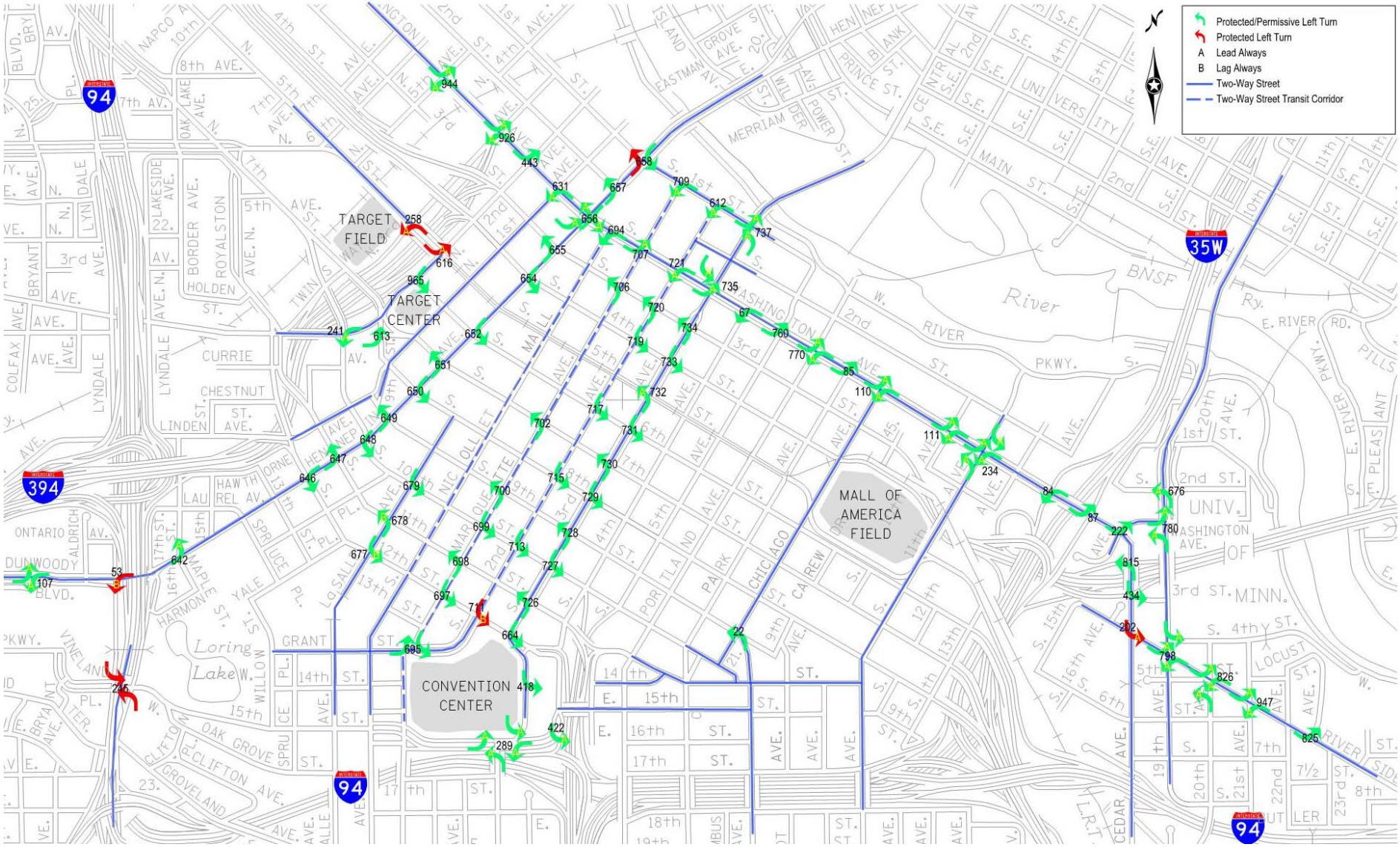


Figure 2. Left Turn Arrow Location and Operation

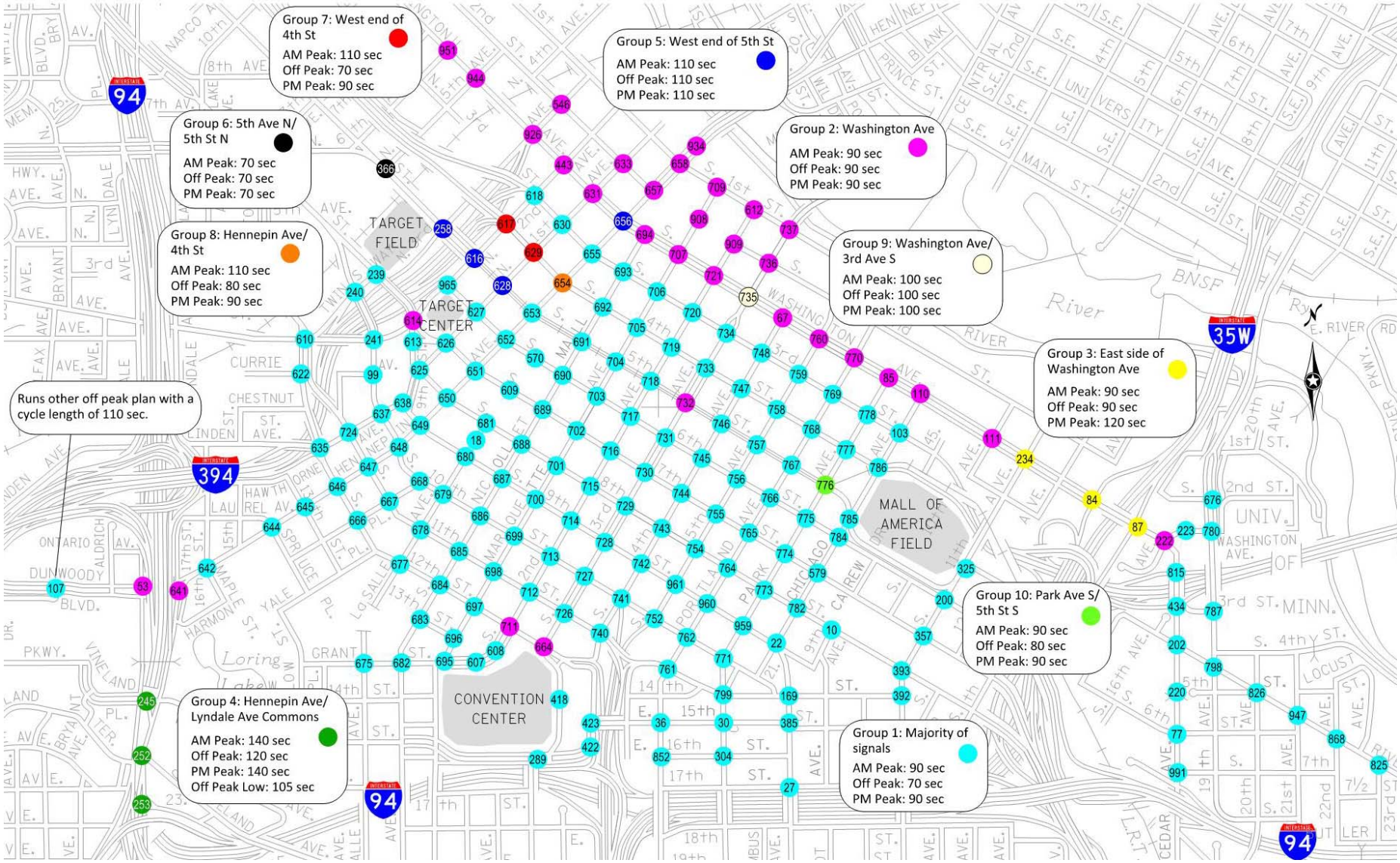


Figure 3. Existing Cycle Lengths

2.1.2 Traffic Volumes

Traffic Data, Inc. conducted turning movement volume counts (vehicle, bicycle, pedestrian and heavy trucks) at each of the 205 intersections during the spring and early summer of 2011. Turning movement counts were obtained through 24-hour video recording and manually counted during the a.m. peak period, mid-day period, and p.m. peak period on weekdays. A 24-hour traffic count was conducted at 39 intersections. Figure 4 illustrates the location of 24 -hour turning movement counts. The raw turning movement counts can be accessed through the City of Minneapolis Traffic Count Management System at http://minneapolis.ms2soft.com/tcds/tsearch.asp?loc=Minneapolis&mod.

Based on the turning movement counts, and 24-hour traffic volume profile, seven volume cases were developed:

- a.m. peak
- a.m. off-peak
- Mid-day low (off peak low)
- Mid-day peak (off peak high)
- p.m. off-peak
- p.m. peak
- Evening

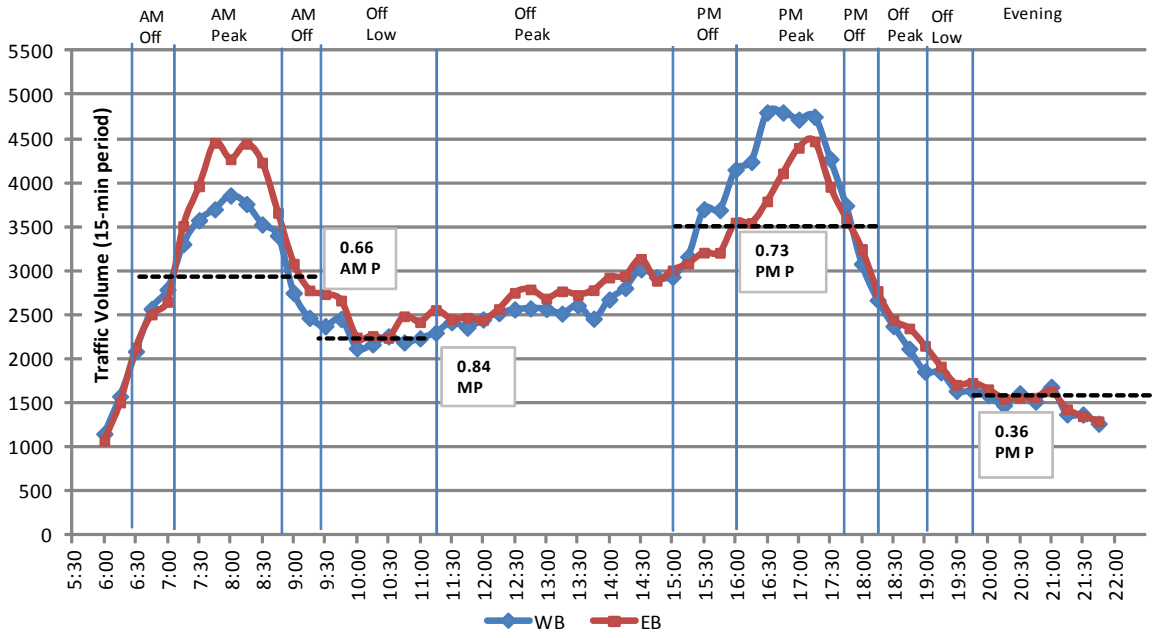
The percentage of heavy trucks observed for each of the traffic volume cases is shown in Table 2. The heavy vehicles were classified as single-unit or those consisting of more than three axles or being a truck and tractor trailer.

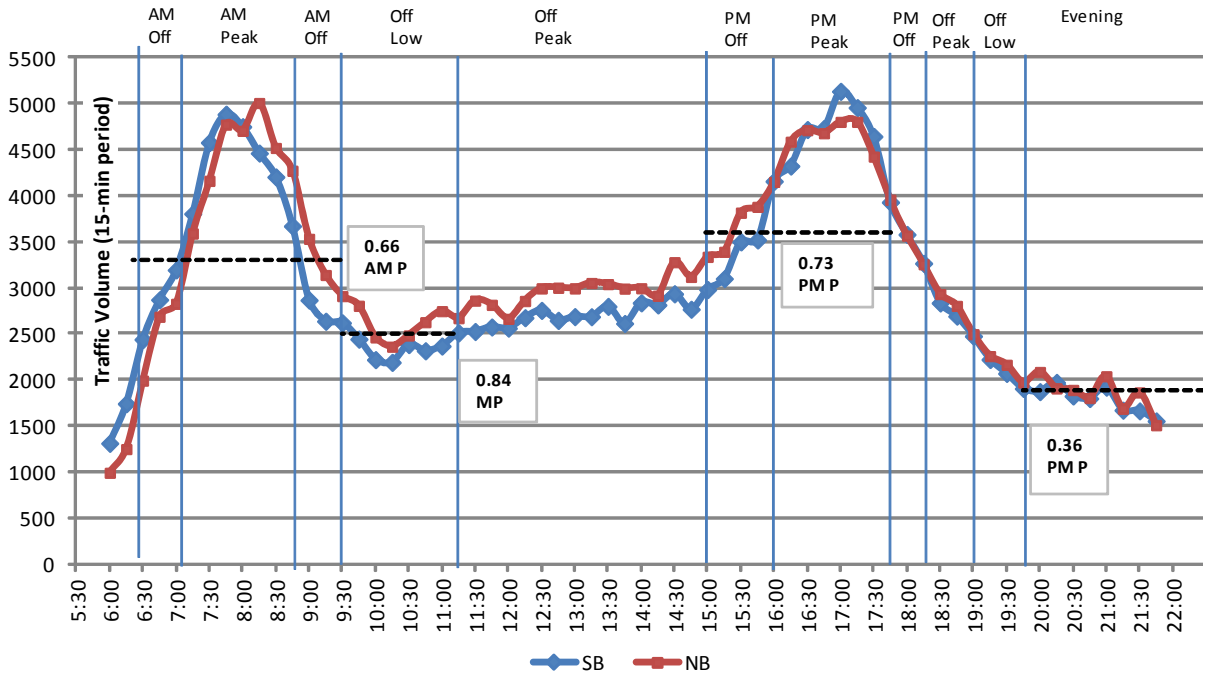
Table 2. Heavy Truck Percentages

Time Period	Traffic Volume Case	Truck Percent
630-715	AM OFF	9%
715-845	AM PEAK	7%
845-930	AM OFF	7%
930-1115	OFF PEAK LOW	8%
1115-1500	OFF PEAK HIGH	6%
1500-1600	PM OFF	7%
1600-1745	PM PEAK	5%
1745-1815	PM OFF	4%
1815-1900	OFF PEAK HIGH	3%
1900-1945	OFF PEAK LOW	3%
1945-2200	EVENING	3%

Table 3 illustrates the general daily traffic volume profile within the Downtown and the scaling factors used to develop the various traffic volume cases.

Table 3. Daily Volume Profiles





In addition to collecting traffic volumes at signalized intersections, 20 parking ramp driveways were studied as illustrated in Figure 5. The parking ramp driveways identified serve large public parking structures and contribute to significant mid block traffic volume source/sinks between intersections.

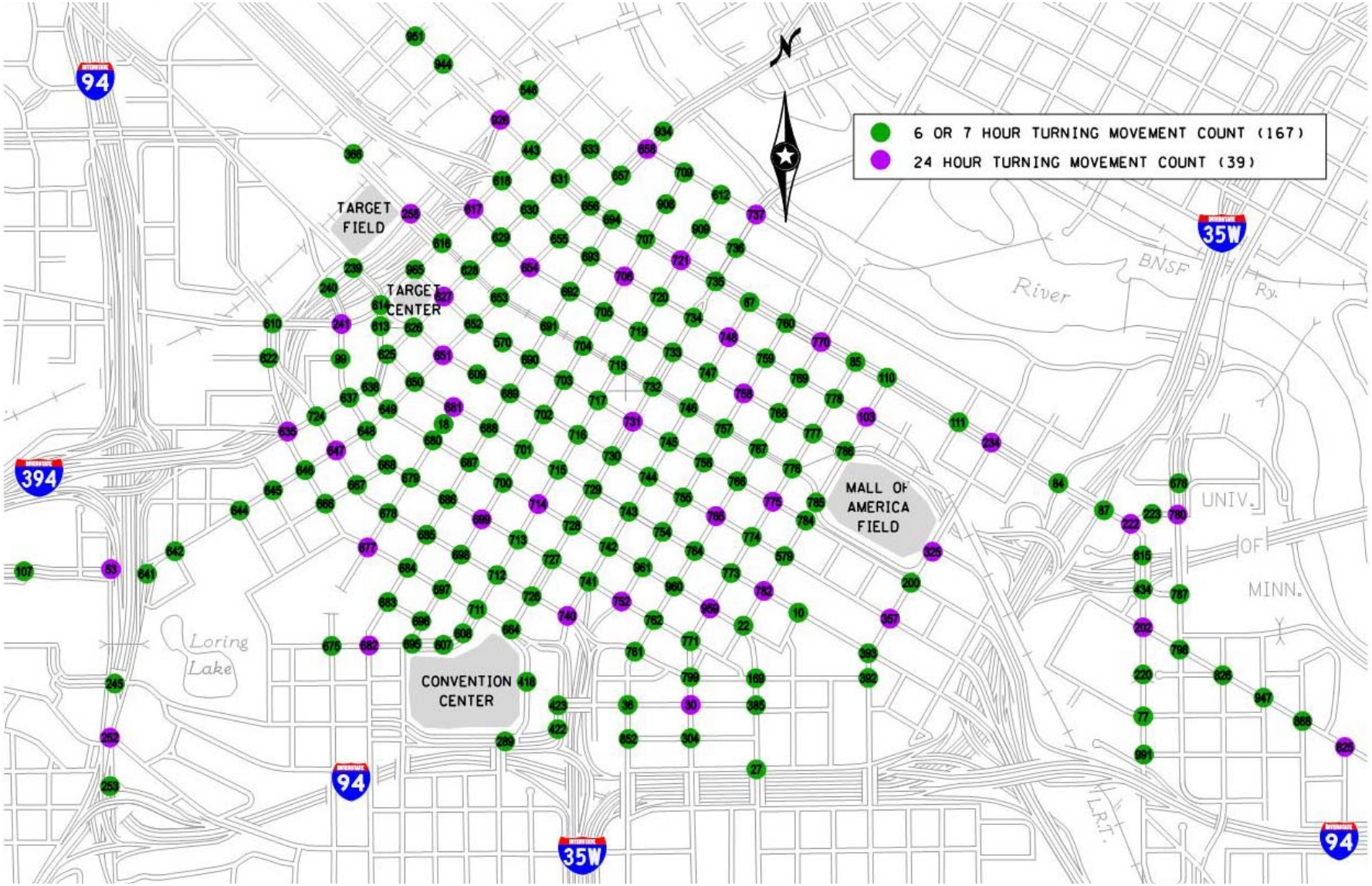


Figure 4. Volume Count Locations (Vehicle, Pedestrian, Bicycle, Heavy Truck)

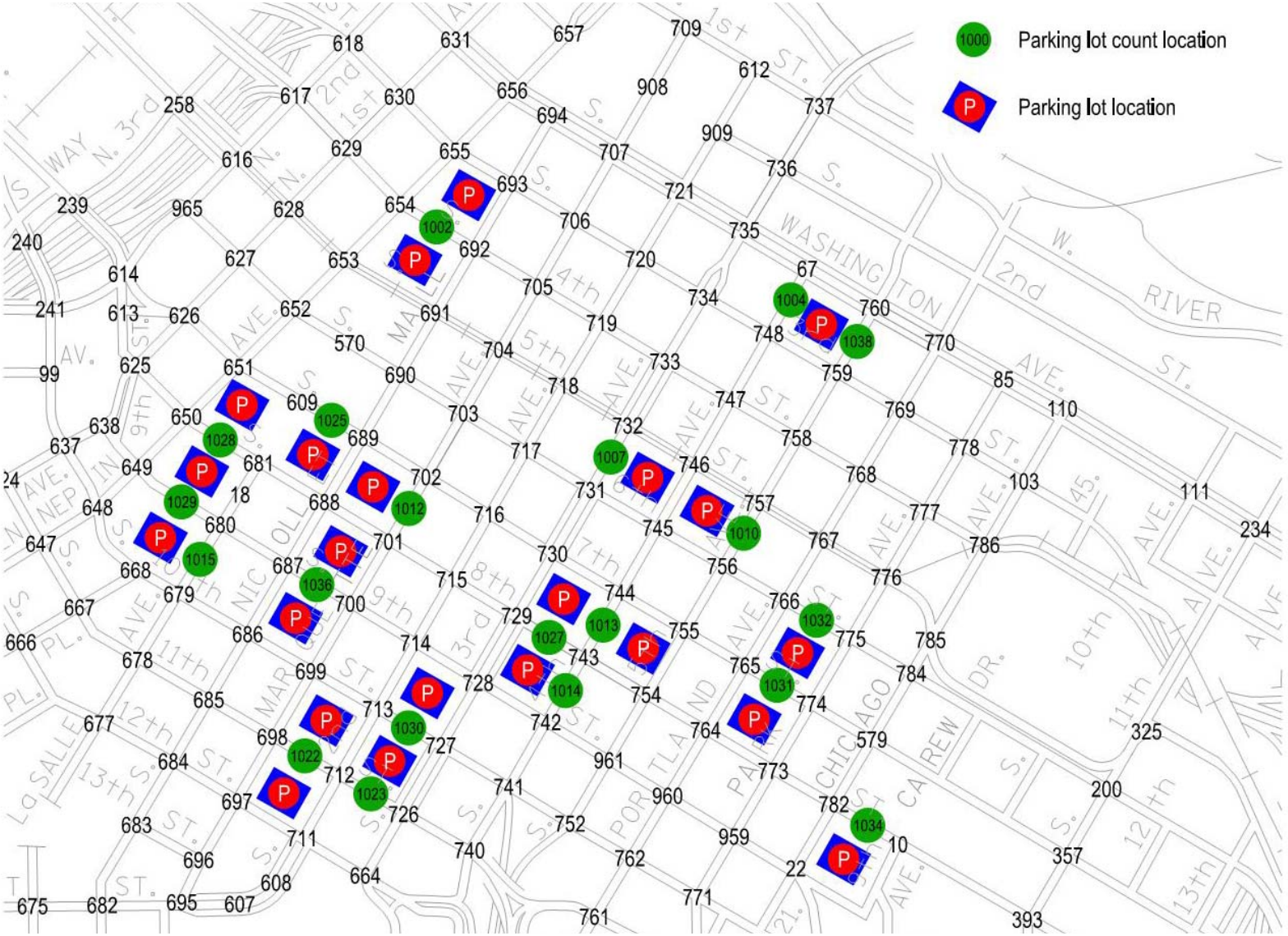


Figure 5. Parking Ramp Driveway Volume Count Locations

2.1.3 Transit Characteristics

Key elements of the transit network were identified and evaluated. Figure 6 illustrates the primary transit corridors (listed in no particular order), location of bus stop (and bus stop type) and location of transit stop inventories. The inventory studies collected number of buses (or LRV) during the study period, number of passengers boarding/alighting, dwell time and percentage of time the traffic lane is not blocked by transit vehicles. The results of the transit stop inventories developed capacity reduction factors that were applied to the Synchro/SimTraffic models.

2.1.4 Saturation Flow Rate

Saturation flow rate studies were completed at several locations throughout the downtown and across many lane type configurations. The saturation flow rates are documented in Table 4. The raw saturation flow rates were adjusted slightly and applied throughout the model at approaches with similar characteristics. The headway factors were adjusted within the Synchro model to correspond with the above saturation flow rates for simulation within SimTraffic.

Table 4. Saturation Flow Rate Studies

Node ID	Intersection	Movement	Saturation Flow Rate[1] (vplphg)
87	Washington Avenue S at 14th Avenue S	EB Left Turn Lane	**2,004**
222	Washington Avenue S at Cedar Avenue S	EB Permissive Thru/Left Lane	**322**
222	Washington Avenue S at Cedar Avenue S	EB Protected Thru/Left Lane	**1,460**
245	Lyndale Avenue S at Vineland Place	SB Thru Lane	**2,027**
252	Lyndale Avenue S at Groveland Avenue	NB Thru Lane	**2,007**
617	4th Street N at 2nd Avenue N	EB Thru Lane	**1,668**
628	5th Street N at 1st Avenue N	SB Thru Lane	**1,320**
648	Hennepin Avenue S at 10th Street N	NB Thru Lane	**1,784**
656	Hennepin Avenue S at Washington Avenue N	WB Thru Lane	**1,757**
656	Hennepin Avenue S at Washington Avenue N	NB Thru Lane	**1,786**
658	Hennepin Avenue S at 1st Street N	SB Thru Lane	**1,721**
706	3rd Street S at Marquette Avenue S	WB Thru Lane	**1,654**
716	7th Street S at 2nd Avenue S	WB Thru Lane	**1,405**
717	6th Street S at 2nd Avenue S	EB Thru Lane	**1,601**
727	10th Street S at 3rd Avenue S	EB Thru Lane	**1,704**
735	Washington Avenue S at 3rd Avenue S	NB Thru Lane	**1,625**
650	Hennepin Avenue S at 8th Street N	NB Shared Thru/Right Lane	**1,426**
701	8th Street S at Marquette Avenue S	NB Shared Thru/Right Lane	**1,155**
715	8th Street S at 2nd Avenue S	EB Right Turn Lane	**1,232**
717	6th Street S at 2nd Avenue S	EB Shared Thru/Right Lane	**1,254**
700	9th Street S at Marquette Avenue S	WB Right Turn Lane	**1,296**

1. Field collected week of August 8, 2011.

NA = Didn't record maximum queue length

Source: On Call Staffing and Alliant Engineering, Inc.

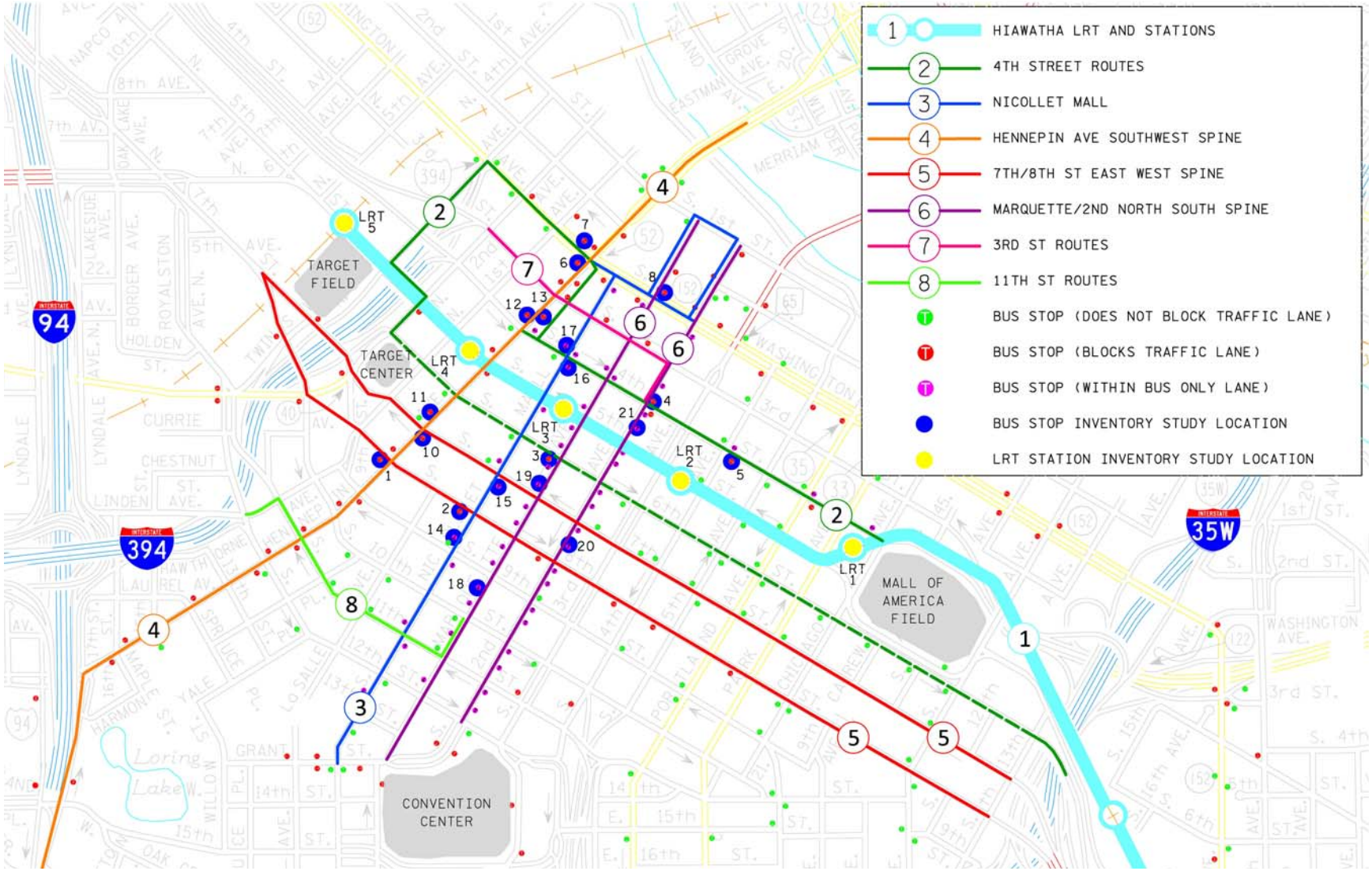


Figure 6. Primary Transit Corridors, Stops and Inventory Studies

2.2 Existing Condition Traffic Operations

The following sections document the a.m., mid-day peak, p.m. peak and Saturday peak hour traffic operation analysis under the existing conditions.

2.2.1. Traffic Operation Analysis

An operations analysis was conducted for the a.m. mid-day and p.m. peak hours. The analysis included an intersection capacity analysis, transit corridor passenger delay, and an arterial level of service for primary street segments. The methods of the Highway Capacity Manual (HCM), 2010 Edition and the Synchro/SimTraffic software model were used to conduct the analysis. LOS criteria as defined by the HCM for both signalized intersections and urban arterials is illustrated in Table 5.

The approach and overall intersection level of service analysis for the a.m., mid-day and p.m. peak hour existing conditions is documented in Appendix A. A summary of the estimated transit corridor bus delay and passenger delay (assuming an average of 30 passengers per bus) is documented in Table 6. The arterial level of service is documented in Table 7.

Table 5. LOS Criteria

LOS	Description	Intersection Delay (Seconds / Vehicle)	Urban Street LOS	
		Signalized Intersection	Travel Speed as a Percentage of Base Free Flow Speed (%)	Base Speed (25 mph) Average Travel Speed (mph)
A	**Free Flow.** Low volumes and no delays.	0 - 10	>85	>25
B	**Stable Flow.** Speeds restricted by travel conditions, minor delays.	>10 - 20	>67	>21
C	**Stable Flow.** Speeds and maneuverability closely controlled due to higher volumes.	>20 - 35	>50	>17
D	**Stable Flow.** Speeds considerably affected by change in operating conditions. High density traffic restricts maneuverability, volume near capacity.	>35 - 55	>40	>13
E	**Unstable Flow.** Low speeds, considerable delay, volume at or slightly over capacity.	>55 - 80	>30	>10
F	**Forced Flow.** Very low speeds, volumes exceed capacity, long delays with stop and go traffic.	> 80	<=30	<=8

Source: Highway Capacity Manual, 2010 Edition, Transportation Research Board, Exhibit 18-4 for Signalized Intersections and Exhibit 16-4 for Urban Street Facilities

Table 6. Transit Corridor Overall Delay Summary – Existing Conditions

Corridor	Transit Corridor	AM Peak Hour		Mid-day Peak Hour		PM Peak Hour	
		Total Bus Delay (hr)	Total Psgr Delay (hr)	Total Bus Delay (hr)	Total Psgr Delay (hr)	Total Bus Delay (hr)	Total Psgr Delay (hr)
2	4th Street Transit Corridor	3.2	97.5	1.1	33.2	1.9	57.2
3	Nicollet Mall Transit Corridor	3.0	91.4	1.9	57.9	3.6	106.7
4	Hennepin Avenue Transit Corridor	6.3	187.8	2.4	72.4	7.4	223.1
5	7th/8th Street Transit Corridor	3.9	116.1	1.6	48.9	4.4	130.9
6	Marquette/2nd Avenue Transit Corridor	10.2	307.1	0.8	24.2	11.2	334.9
7	3rd Street Transit Corridor	0.1	2.2	0.0	1.0	1.3	39.0
8	11th Street Transit Corridor	0.4	12.2	0.1	2.5	2.5	73.8
Total All Corridors		27.1	**814.3**	**8.0**	**240.0**	**32.2**	**965.6**

Note: The transit corridor route number cross-references with Figure 6. The primary corridors are not listed in any particular order of priority.

Table 7. Existing Arterial Level of Service

Northbound / Eastbound

Route #	Corridor	AM Peak Hour		Mid-Day Peak Hour		PM Peak Hour	
		Average Travel Speed (mph)	LOS	Average Travel Speed (mph)	LOS	Average Travel Speed (mph)[1]	LOS
1	Washington Avenue From N 6th Ave To I-35W Northbound (East Ramp)	10.6	D	12.7	C	6.2	**F**
2	4th Street From N 1st Ave To Chicago Avenue	8.2	**E**	10.5	D	10.3	D
3	6th Street From N 1st Ave To S 11th Ave	7.8	**E**	11.5	D	8.4	**E**
4	8th Street From Hennepin Avenue To S 11th Ave	8.6	**E**	11.5	D	9.6	**E**
5	10th Street From Twins Way To Chicago Avenue	7.1	**F**	10.3	D	8.5	**E**
6	1st Avenue From 11th St N To 2nd St N	8.1	**E**	9.1	**E**	6.3	**F**
7	Hennepin Avenue From N Lyndale Ave To 1st St S	8.0	**E**	11.1	D	7.6	**E**
8	Park Avenue From 16th St E To Washington Avenue	11.6	D	12.7	C	11.4	D
9	3rd Avenue From 16th St E To 2nd St SE	8.0	**E**	9.5	**E**	6.5	**F**
10	5th Avenue From 3rd St S To 9th St S	10.6	D	12.6	C	10.5	D
Average of All Corridors		**8.6**	**E**	**11.1**	D	**7.9**	**E**

Southbound / Westbound

Route #	Corridor	AM Peak Hour		Mid-Day Peak Hour		PM Peak Hour	
		Average Travel Speed (mph)	LOS	Average Travel Speed (mph)	LOS	Average Travel Speed (mph)[1]	LOS
1	Washington Avenue From I-35W Northbound (East Ramp) To N 6th Ave	9.6	**E**	10.2	D	7.2	**F**
2	3rd Street From Chicago Avenue To 2nd Ave N	10.4	D	11.2	D	9.0	**E**
4	7th Street From S 11th Ave To Twins Way	10.0	**E**	11.4	D	8.6	**E**
5	9th Street From Chicago Avenue To Hawthorne Avenue	10.3	D	11.5	D	9.1	**E**
6	1st Avenue From 2nd St N To 12 St N	7.7	**E**	9.5	**E**	7.6	**E**
7	Hennepin Avenue From High St S/Robert Fischer Dr To 15th St W	9.3	**E**	9.9	**E**	8.3	**E**
8	Portland Avenue From Washington Avenue To 16th St E	10.8	D	12.4	D	10.9	D
9	3rd Avenue From 2nd St S To 14th St E	8.7	**E**	10.1	D	8.6	**E**
10	4th Avenue From 3rd St S To 10th St S	10.3	D	11.7	D	9.2	**E**
Average of All Corridors		**9.6**	**E**	**10.7**	D	**8.5**	**E**

[1] SimTraffic model ouput for AM and PM peak hours. Synchro model output for Mid-day and Saturday scenario.

2.2.2 Existing Network Performance Measures

The existing total network performance was evaluated for the a.m. peak, mid-day, p.m. peak and remaining off peak periods. Key measures of effectiveness (MOE's) include overall delay (hours), vehicle stops, fuel consumption and air quality emissions (CO, NOx, and VOC). Table 8 documents the existing condition network performance measures.

Table 8. Existing Network Performances Measures

	MOE	Existing ("Before")			
		AM Peak	Mid-Day Peak	PM Peak	Remaining Off Peak Hours
Minneapolis - CBD Signals	Stops (no. of veh)	298,031	454,819	407,061	993,478
	Delay (hr)	2,836	3,383	4,301	7,144
	Fuel Consumption (gal)	4,431	6,430	6,027	17,655
	Emission (CO) (kg)	610	973	727	1,240
	Emission (NOx) (kg)	97	151	116	240
	Emission (VOC) (kg)	63	94	84	288

AM Peak: 715 to 845 AM
Mid-Day Peak: 1115 AM to 300 PM
PM Peak: 400 PM to 545 PM
Off Peak: 600-715 AM, 845 AM to 1115 AM, 300 PM to 400 PM, 545 PM to 1100 PM

3.0 Signal Timing Optimization

The traffic signal optimization included conducting a network traffic analysis to determine signal groups and cycle lengths, conducting a detailed evaluation of 5th Street LRT operations, a detailed evaluation of Marquette Avenue/2nd Avenue bus corridor, and developing time of day (TOD) timing plans consisting of new cycle lengths, intersection splits and offsets for each group. In general, the cycle length selection and network optimization is predicated upon the following considerations:

- Meeting pedestrian clearance interval minimums while providing a common cycle length throughout the Downtown CBD network.
- Selecting the minimum cycle length to achieve optimum light rail operation.
- Providing priority travel for key bus transit corridors (common cycle length);
- Maintaining balanced progression along the two-way streets; and
- Inner core one-way street grid operation.

3.1 Base Timing Parameters and Minimum Cycle Lengths

As part of the signal optimization process, the existing local controller timing parameters were reviewed and updated to be in accordance with the latest requirements of the Minnesota Manual on Uniform Traffic Control Devices (MMUTCD). The following key local controller settings include:

- **Minimum Initial Time (Minimum Green)**
  Minimum green times are set to the movement type and signal phase operation and should be consistent city wide. The following minimum green values are standard.
  - *Major Approach = 10 seconds (15 seconds for speeds >40 mph)*
  - *Minor Approach = 10 seconds*
  - *Split Phased or Ramp Terminal Approach = 10 seconds*
  - *Left Turn Arrow (protected or protected/permissive) = 5 seconds*
  - *Pedestrian Only Phase = Minimum Initial should match Walk interval*

- **Yellow Clearance**
  Yellow intervals are based on the perception-reaction time of the motorist (1 second), the posted speed limit, approach grade and deceleration rate of the vehicle (10 feet per second per second). The generalized standard is as follows:
  - *25 mph = 3.0 seconds*
  - *30 mph = 3.5 seconds (also use with left turn arrow)*
  - *35 mph = 4.0 seconds*

- **All Red Clearance**

The All Red is calculated based on the following formula rounded up to the nearest 0.5 second:

- *All Red = (Intersection Clearance Width + 20) * 0.68 / Speed (mph)*

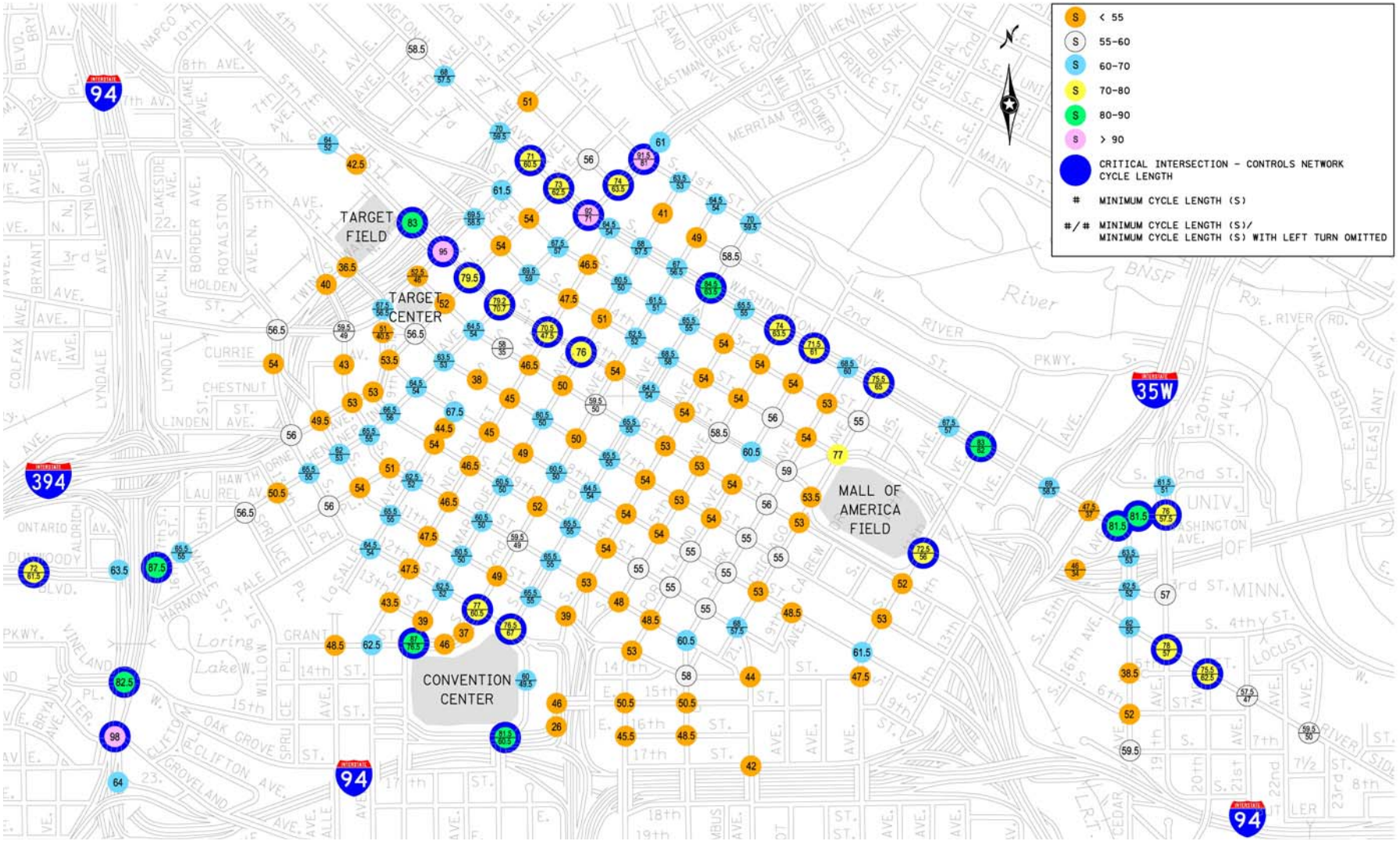
The Intersection Clearance Width is determined using the parallel crosswalk length (use for standard intersection with no skew); or the distance from stop bar to furthest curb line extended (asymmetrical or unique intersection alignment). All left turn phases were assumed to have an all red time of 2.0 seconds.

- **Pedestrian Interval**

  The pedestrian interval consists of the "Walk" time and the "Don't Walk" time. The pedestrian intervals are calculated to cross pedestrians the full distance of the roadway and to account for a 3.5 feet per second walking speed per the Minnesota Manual on Uniform Control Devices (MMUTCD) requirement. The following pedestrian interval standards were applied:

  - *Walk Interval = 7.0 seconds for all signals except those with a median bush button. If median push button is provided, then the Walk is equal to the total time required to cross the full distance minus the flashing Don't Walk interval.*
  - *Flashing Don't Walk Interval = Total time to cross full distance of roadway divide by 3.5 feet per second, and minus the yellow time. If a median push button is provided, then the Flashing Don't Walk interval is equal to the time to cross the longest distance to the median divide by 3.5 and minus yellow time. The minimum Flashing Don't Walk Interval was assumed to be 6.0 seconds (4.0 seconds is the minimum value required by the MMUTCD).*
  - *Actuated Rest in Walk. The actuated rest in walk function allows the Walk indication to remain illuminated for the duration of the vehicle green time, minus the Flashing Don't Walk. When enabled, in most circumstances the Walk will be displayed for much greater than the minimum value. Actuated Rest in Walk is used on all pedestrian crosswalk intervals without a push button.*

The summation of these minimum local controller settings for each phase, and combination of phase sequences, at an intersection equate to the raw minimum cycle length. It should also be noted the minimum cycle length that can be selected must be further increased to account for rounding "buffer time" on each phase and flexibility to accommodate varying traffic demand (typically applies to left turn phases). The raw minimum cycle lengths for each intersection are illustrated on Figure 7. Based on this analysis, absent omitting left turn arrows (at protected/permissive operation locations) the shortest feasible even, whole cycle length for the entire downtown to be on a common cycle is 100 seconds.



Note: Minimum Cycle Length represents the minimum amount of time required to service pedestrian clearance intervals, vehicle minimum greens, and vehicle clearance intervals for the summation of signal phases at the intersection. The network cycle length must be greater than the controlling critical intersection minimum cycle length.

Figure 7. Minimum Cycle Lengths

3.2 Network Cycle Length Analysis

To achieve the project goals, the optimum network signal system cycle length must incorporate the following considerations:

- The minimum cycle length required to accommodate MMUTCD compliant pedestrian intervals and servicing of all intersection signal phases.
- The two-way street corridors and determining the optimum cycle length for each corridor based upon the speed/signal spacing data and corridor green time splits for balanced two-way vehicle progression.
- The length of cycle that best balances improved flow for vehicles, bicycles and transit progression, but does not impose added delay to pedestrians.
- Minimum cycle length required to provide station-to-station progression for the light rail transit corridor.
- Minimum or common cycle length required to accommodate the transit characteristics and provide improved traffic flow on the priority transit corridors (e.g., Marquette Avenue, 2nd Avenue and Nicollet Mall).
- Outer-core versus inner core cycle length requirements. Ultimately does it make sense to operate the entire network on a single cycle length, or is the performance improved with strategic coordination "zone" breaks.

Ultimately these factors are evaluated and weighed together to arrive at the shortest optimum network cycle length for each time period. The network cycle length analysis process included three steps: the first step determined the minimum cycle lengths, the second evaluated the cycle length needs of specific corridors (e.g., two streets versus transit corridors versus 5th Street LRT and outer core versus inner core grid) and the final step evaluated the performance of five distinct network cycle length combination scenarios. The key conclusions of this analysis are as follows:

- Detailed VISSIM modeling of 5th Street found that station-to-station two-way train progression can be achieved with a 110 second cycle length and a few signal sequencing/detection improvements. Under this scenario, significant benefit to the light rail operations (benefit to riders) is expected. Refer to Section 3.5.3.
- Each of the two-way streets (specifically Washington Avenue, Hennepin Avenue, 1st Avenue and 3rd Avenue) benefit by increasing the cycle length beyond the existing 90 seconds to improve mobility in both directions, and to facilitate high vehicle demand at key intersections.
- The analysis found that Marquette Avenue and 2nd Avenue provide for best bus transit performance if a consistent cycle length is provided between 12th Street S and Washington Avenue. A cycle length break along any of these corridors should not be considered.
- The inner core one-way grid (i.e., area bounded by 3rd Avenue S, Washington Avenue S, 12th Street S and Chicago Avenue S), could operate on a cycle length as low as 60 seconds. However, during peak hours, a 60 seconds cycle is not expected to accommodate the volume demand; and the analysis found the delay

benefit is offset when a non-common cycle length boundary is introduced in the network.

- The analysis found that during the off peak hours that the Washington Avenue, Hennepin Avenue, 1st Avenue corridors must operate on a common cycle length. However, the CBD grid network to the east and south could operate on a single, shorter cycle length. In this case, the minimum cycle length to meet pedestrian clearance intervals should be used (80 seconds).
- The Riverside Avenue and the Lyndale Avenue/Hennepin Avenue commons areas are independent of the CBD and should operate on the minimum required cycle length to meet the individual pedestrian interval requirements and traffic demand of the corridors.

During the peak hours, the evaluation finds that providing a common cycle length throughout the downtown CBD provides for the most optimum and balanced network operation. Balancing all the considerations, the optimum common cycle length during the a.m. and p.m. peak periods was found to be 110 seconds. The optimum cycle length within the CBD core during the off peak periods is 80 seconds.

3.3 Optimized Timing Plans

Based upon the network optimization analysis, Figure 8 graphically summarizes the Downtown signal groups and cycle lengths by general time period.

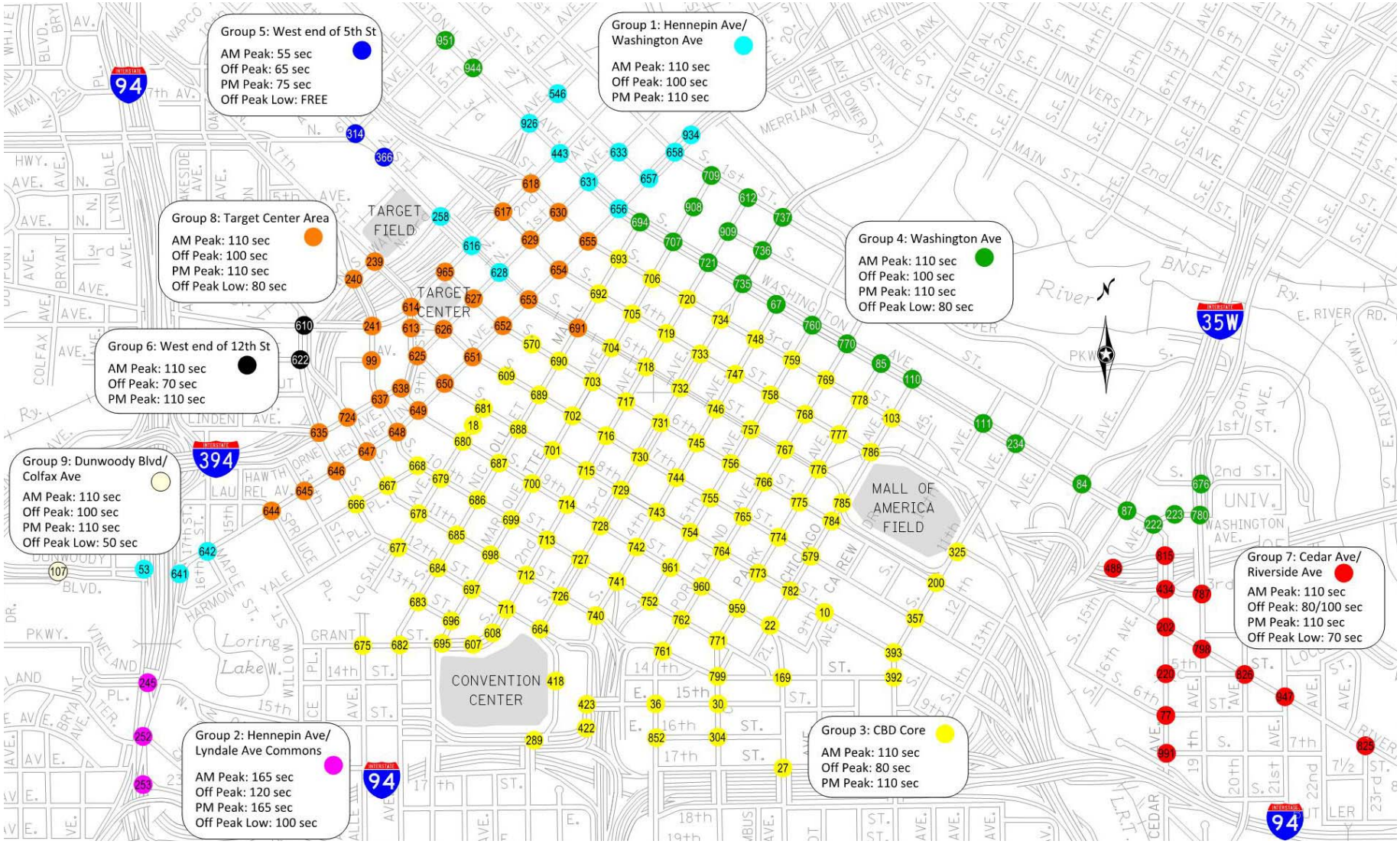


Figure 8. Downtown Signal Groups and Cycle Lengths

3.3.1 Intersection Splits and Offsets

Intersection splits and offsets are optimized to accommodate all pedestrian intervals and to best arrive at efficient grid network operation. Left turn arrows are evaluated on a case by case basis to determine sequence (lead or lag where possible) or when to be omitted. The decision to omit a left turn arrow is weighed across several considerations; including, the ability to fit it within the cycle length, actual volume demand and benefit to vehicle progression.

3.3.2 Time of Day Schedule

The typical TOD schedule for each signal group within the Downtown Retiming Project is summarized in Table 9. The schedule was developed based on a comprehensive evaluation of the daily traffic volume patterns, trends and circulation throughout the CBD. Furthermore, the schedule was developed to maximize the provision of providing consistent cycle lengths throughout the CBD while also operating the shortest possible cycle lengths for the maximum amount of time in relation to the traffic volume patterns, and takes advantage of key locations where non-matching cycle lengths minimizes traffic impacts. The plan numbering sequence used within Tactics Central Management Software and the local EPAC controllers (Dial (D) / Split (S) / Offset (O)) follows the following convention for the range of plan types:

- AM Peak: 2/1/1
- PM Peak: 3/1/1
- Off Peak High: 1/1/1
- Off Peak Low: 1/2/1
- Off Peak Medium: 1/3/1

The cycle lengths for each timing pattern listed above are illustrated in Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13.

Table 9. Signal Timing Plans Time of Day Schedule

Group 1: Hennepin Avenue/1st Avenue /2nd Avenue (Dunwoody Interchange and Washington Avenue to the North)

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 645 AM	0:00:00	111	100	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 230 PM	9:00:00	111	100	OP
		230 PM to 615 PM	14:30:00	311	110	PMP
		615 PM to Midnight PM	18:15:00	111	100	OP
Saturday / Sunday (Day Plan 1)	TOD	Midnight to Midnight	0:00:00	111	100	OP

Group 2: Hennepin Avenue/Lyndale Avenue Commons Area

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 630 AM	0:00:00	121	100	OPL
		630 AM to 900 AM	6:30:00	211	165	AMP
		900 AM to 230 PM	9:00:00	111	120	OP
		230 PM to 630 PM	14:30:00	311	165	PMP
		630 PM to 900 PM	18:30:00	111	120	OP
		900 PM to Midnight	21:00:00	121	100	OPL
Saturday / Sunday (Day Plan 1)	TOD	Midnight to 900 AM	0:00:00	121	100	OPL
		900 AM to 900 PM	9:00:00	111	120	OP
		900 PM to Midnight	21:00:00	121	100	OPL

Group 3: CBD Core

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 645 AM	0:00:00	111	80	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 315 PM	9:00:00	111	80	OP
		315 PM to 615 PM	15:15:00	311	110	PMP
		615 PM to Midnight	18:15:00	111	80	OP
Saturday / Sunday (Day Plan 1)	TOD	Midnight to Midnight	0:00:00	111	80	OP

Group 4: Washington Avenue and Seven Corners

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 600 AM	0:00:00	121	80	OPL
		600 AM to 645 AM	6:00:00	111	100	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 230 PM	9:00:00	111	100	OP
		230 PM to 615 PM	14:30:00	311	110	PMP
		615 PM to 1100 PM	18:15:00	111	100	OP
		1100 PM to Midnight	23:00:00	121	80	OPL
Saturday / Sunday (Day Plan 1)	TOD	Midnight to 900 AM	0:00:00	121	80	OPL
		900 AM to 1100 PM	9:00:00	111	100	OP
		1100 PM to Midnight	23:00:00	121	80	OPL

Group 5: West End 5th Street N

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 645 AM	0:00:00	0/0/4	FREE	OPL
		645 AM to 900 AM	6:45:00	211	55	AMP
		900 AM to 230 PM	9:00:00	111	65	OP
		230 PM to 615 PM	14:30:00	311	75	PMP
		615 PM to 700 PM	18:15:00	111	65	OP
		700 PM to Midnight	19:00:00	0/0/4	FREE	OPL
Saturday / Sunday (Day Plan 1)	TOD	Midnight to 900 AM	0:00:00	0/0/4	FREE	OPL
		900 AM to 700 PM	9:00:00	111	65	OP
		700 PM to Midnight	19:00:00	0/0/4	FREE	OPL

Group 6: 12th Street N/Glenwood/Currie Avenue

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 645 AM	0:00:00	111	70	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 315 PM	9:00:00	111	70	OP
		315 PM to 615 PM	15:15:00	311	110	PMP
		615 PM to Midnight	18:15:00	111	70	OP
Saturday / Sunday (Day Plan 1)	TOD	Midnight to Midnight	0:00:00	111	70	OP

Group 7: Cedar Avenue/Riverside Avenue Area

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 715 AM	0:00:00	121	70	OPL
		715 AM to 900 AM	7:15:00	211	110	AMP
		900 AM to 1130 AM	9:00:00	131	80	OP M
		1130 AM to 230 PM	11:30:00	111	100/80	OP H
		230 PM to 600 PM	14:30:00	311	110	PMP
		600 PM to 700 PM	18:00:00	131	80	OP M
		700 PM to Midnight	19:00:00	121	70	OPL
Saturday / Sunday (Day Plan 1)	TOD	Midnight to 1100 AM	0:00:00	121	70	OPL
		1100 AM to 500 PM	11:00:00	131	80	OP M
		500 PM to Midnight	17:00:00	121	70	OPL

Group 8: Hennepin Avenue/1st Avenue/2nd Avenue (3rd Street to Spruce Place)

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Mon-Thurs) (Day Plan 2)	TOD	Midnight to 615 AM	0:00:00	121	80	OPL
		615 AM to 645 AM	6:15:00	111	100	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 230 PM	9:00:00	121	80	OPL
		230 PM to 615 PM	14:30:00	311	110	PMP
		1815 PM to 800 PM	18:15:00	111	100	OP
		800 PM to Midnight	20:00:00	121	80	OPL
Saturday (Day Plan 7)	TOD	Midnight to 230 AM	0:00:00	111	100	OP
		230 AM to 1700 PM	2:30:00	121	80	OPL
		1700 PM to Midnight	17:00:00	111	100	OP
Weekday (Friday) (Day Plan 6)	TOD	Midnight to 615 AM	0:00:00	121	80	OPL
		615 AM to 700 AM	6:15:00	111	100	OP
		700 AM to 900 AM	7:00:00	211	110	AMP
		900 AM to 230 PM	9:00:00	121	80	OPL
		230 PM to 615 PM	14:30:00	311	110	PMP
		1815 PM to 1159 PM	18:15:00	111	100	OP
Sunday (Day Plan 1)	TOD	Midnight to 230 AM	0:00:00	111	100	OP
		230 AM Midnight	2:30:00	121	80	OPL

Group 9: Dunwoody Boulevard/Colfax Avenue

Type	Operation	Time	Timebase Start Time	Timing Plan (D/S/O)	Cycle Length (s)	Volume
Weekday (Day Plan 2)	TOD	Midnight to 615 AM	0:00:00	121	50	OPL
		615 AM to 645 AM	6:15:00	111	100	OP
		645 AM to 900 AM	6:45:00	211	110	AMP
		900 AM to 230 PM	9:00:00	121	50	OPL
		230 PM to 615 PM	14:30:00	311	110	PMP
		300 PM to 330 PM	15:00:00	321	110	School
		330 PM to 615 PM	15:30:00	311	110	PMP
		1815 PM to 800 PM	18:15:00	111	100	OP
		800 PM to Midnight	20:00:00	121	50	OPL
Saturday / Sunday (Day Plan 1)	TOD	Midnight to Midnight	0:00:00	121	50	OP

3.3.3 Special Event Timing Plans

Several special event timing plans were developed. A summary of the special event plans include:

- Target Field/Target Center Outbound Event Plan (411). Plan 411 is a 110 second cycle evening and mid-day event stadium exit plan. Plan 411 modifies the existing event plan (110 second cycle event plan developed in year 2010 with the opening of Target Field) and extends the plan to the intersections east of 3rd Avenue S. The event plan 411 varies from the 110 second PM peak (Plan 311) in that it focuses on exiting the A, B, C Ramps and gives priority progression to downtown exiting streets from the west end of downtown (e.g., 4th Street, 6th Street, 10th Street, Hennepin Avenue (both directions), 10th Street and 2nd Avenue N). The 5th Street 110 second light rail timing plan (developed for the weekday

a.m. and p.m. peak periods) has been designed to also work with the existing Target Field event timing. Intersections included within the Target Field/Target Center event plan are illustrated in Figure 14.

- Dunwoody Institute Dismissal Plan (321). Plan 321 is a 110 second cycle length and is designed to provide compatible operation with the adjacent signals on Hennepin Avenue running the p.m. peak plan (311).
- Holidazzle Parade (141). Plan 141 is a 100 second cycle with simultaneous green on Nicollet Mall. This plan is designed to be compatible with Plan 111, which operates concurrently on Hennepin Avenue and to the west (Groups 1, 8 and 9) during this time.
- Lowry Tunnel Closure Plan (441). Plan 441 is a 165 second cycle length and is designed to provide as much southbound green time as possible.

Intersections using the Dunwoody Institute, Holidazzle or Lowry Tunnel Closure plans are illustrated on Figure 15.

3.3.4 Adverse Weather Timing Plans

Adverse weather (snow) timing plans were developed as part of the Downtown Retiming Project. The objective of the snow plan is to recognize that motor vehicle start up time, travel speed and intersection capacities are reduced during inclement weather and to attempt to better move the traffic flow under these conditions. The following snow plan assumptions are made:

- The average vehicle travel speed is 15 mph (normal design speed is 25 mph)
- The intersection saturation flow rate (1,750 vphplg) is reduced by approximately 20 percent (to 1,450)
- There is an additional one second of intersection lost time.
- There will be a reduction in intersection traffic volume.

Since the actual vehicle travel speeds will be highly dependent upon the road conditions and level of snow fall, a wide range of speeds could be expected. This factor serves to greatly diminish the value of snow plans along traditional arterial corridors. However, since the signal spacing within the downtown area is very close (330 foot blocks) the best operation to accommodate unknown and variable vehicle speeds is simultaneous green operation. Two snow plans were developed for Minneapolis – an a.m. peak period (Plan 431) and a p.m. peak period (Plan 421). The snow plans utilize the same 110 second cycle length, provide simultaneous green within the downtown core, provide slightly increased left turn arrow splits (where possible), and account for the inbound/outbound directional differences between the two periods (e.g., Washington Avenue at 35W during the p.m., versus inbound 4th Street at 2nd Avenue N in the a.m.).

The snow plans require manual activation through Tactics Central Management Software. It is recommended the City only use these plans specific for adverse travel conditions and poor roadway conditions. It is also suggested that the snow plans not be used during the off peak or weekend time periods as added value is not expected.

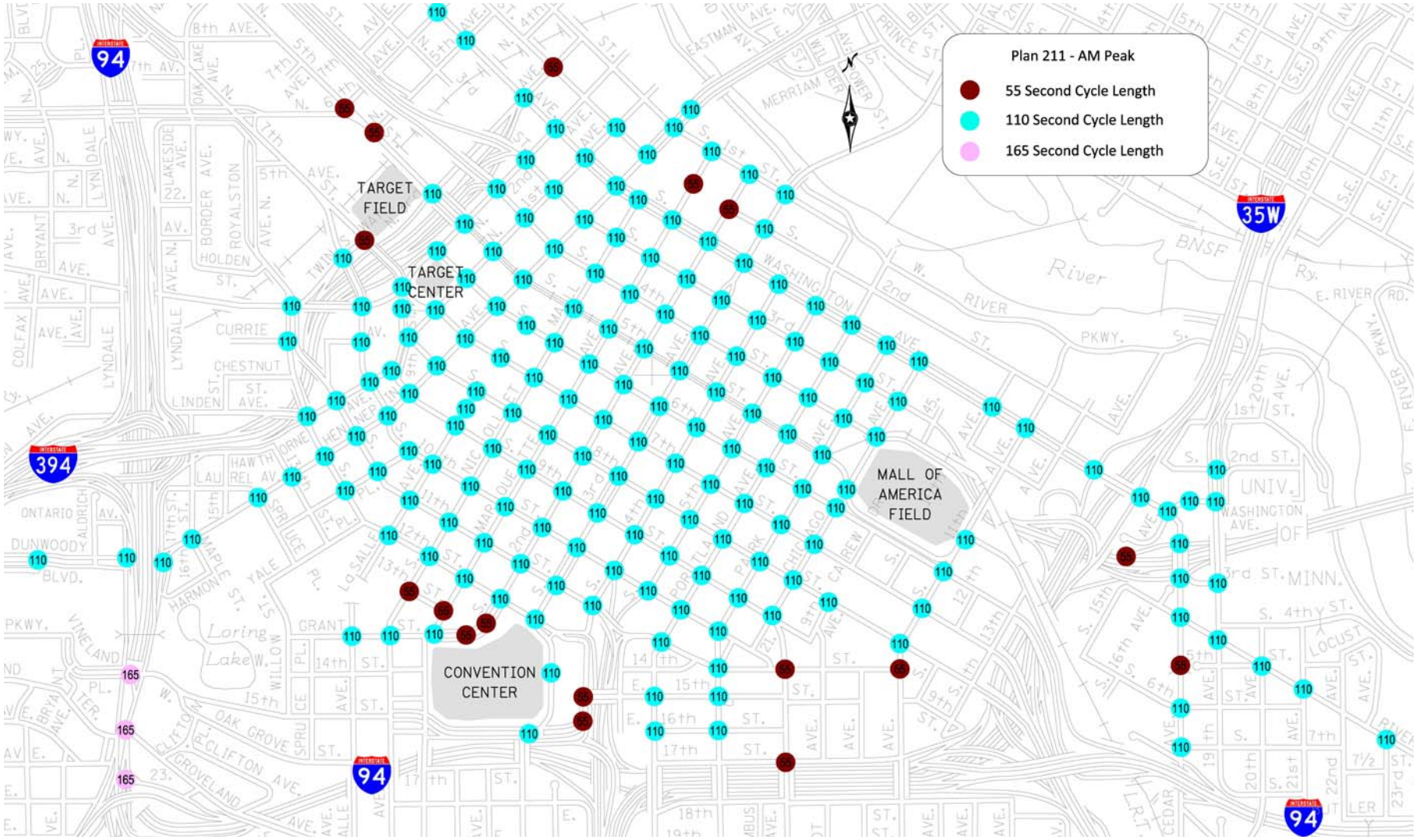


Figure 9. AM Peak Plan 211 and Cycle Lengths

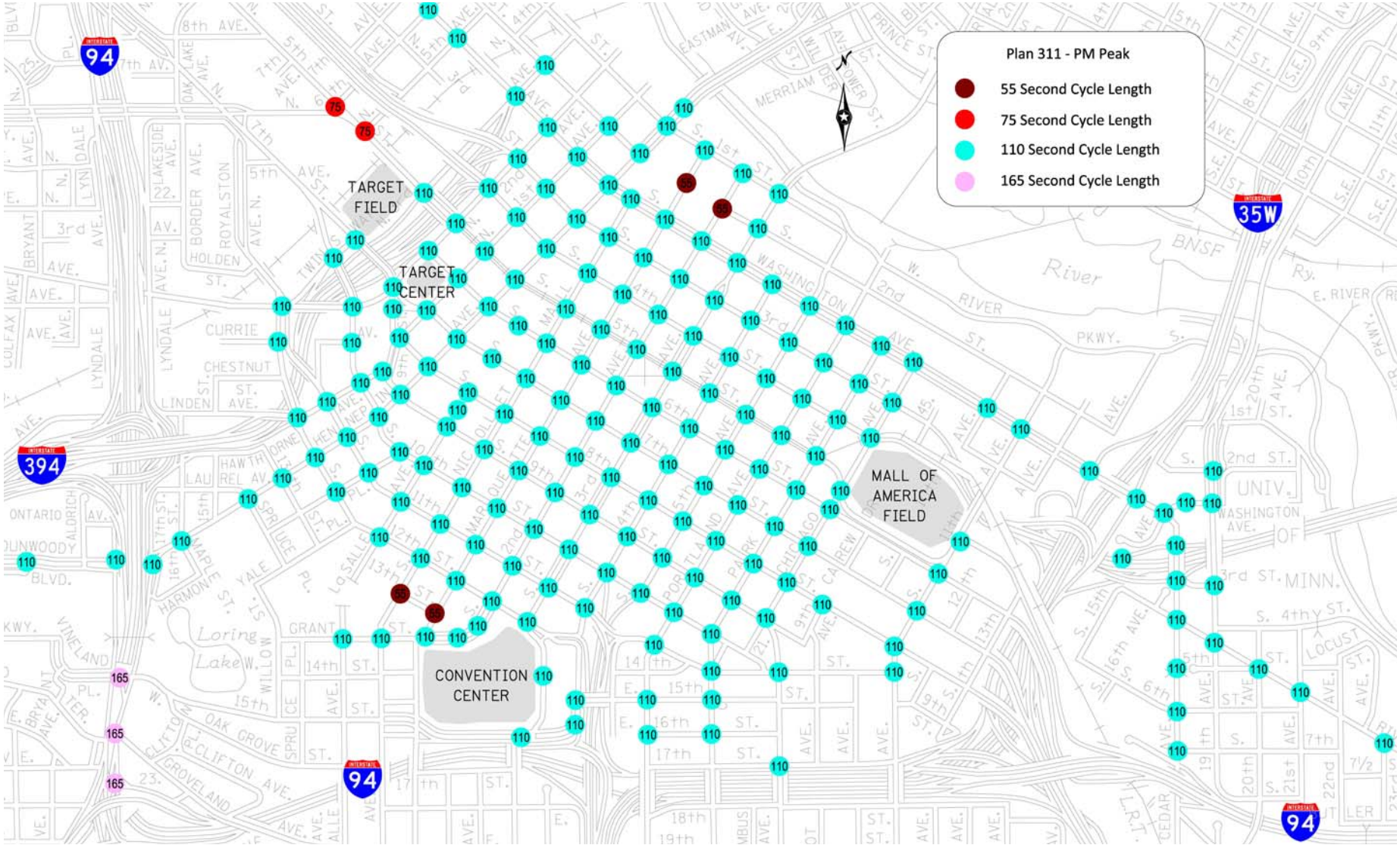


Figure 10. PM Peak Plan 311 and Cycle Lengths

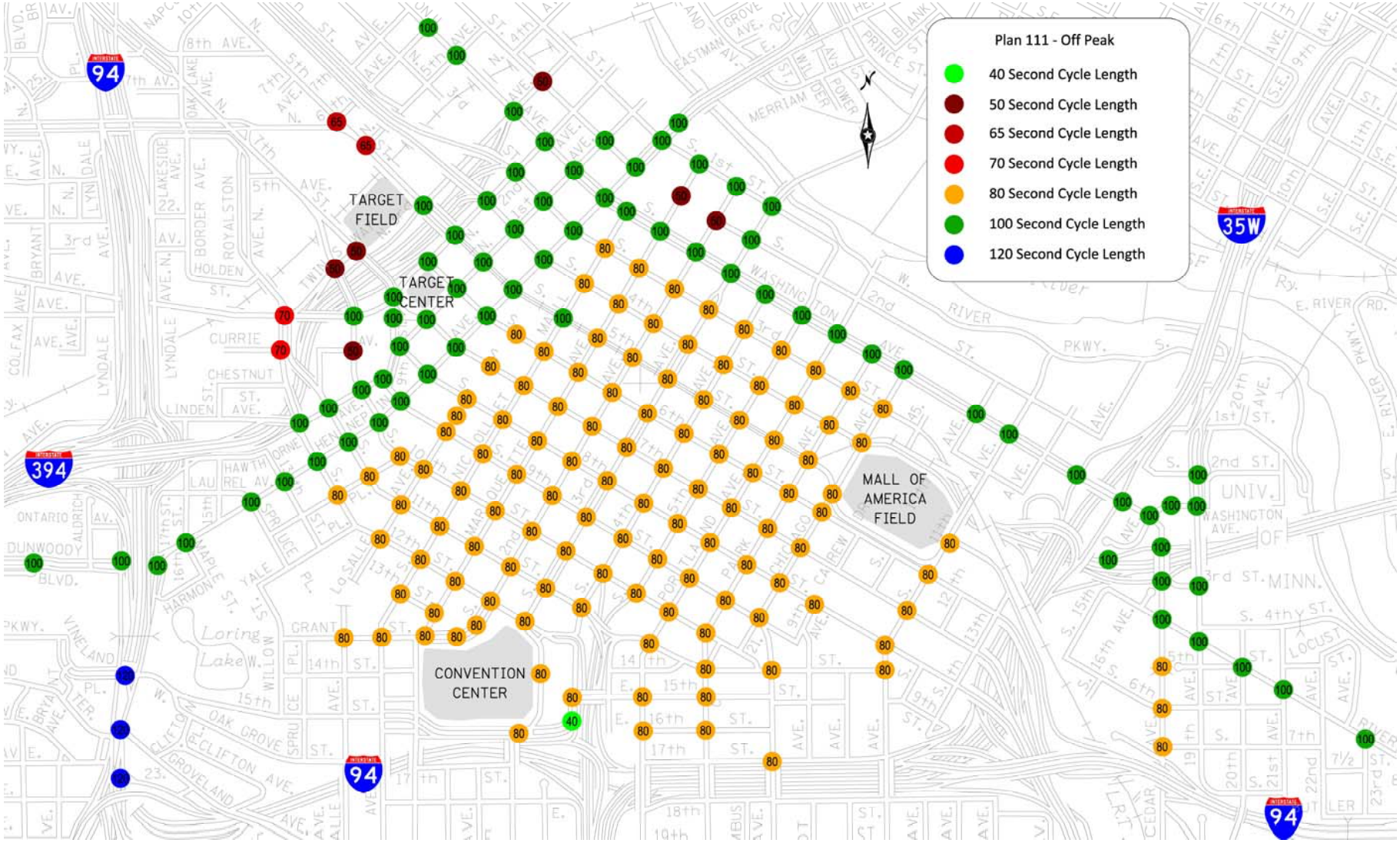


Figure 11. Off Peak High Plan 111 and Cycle Lengths

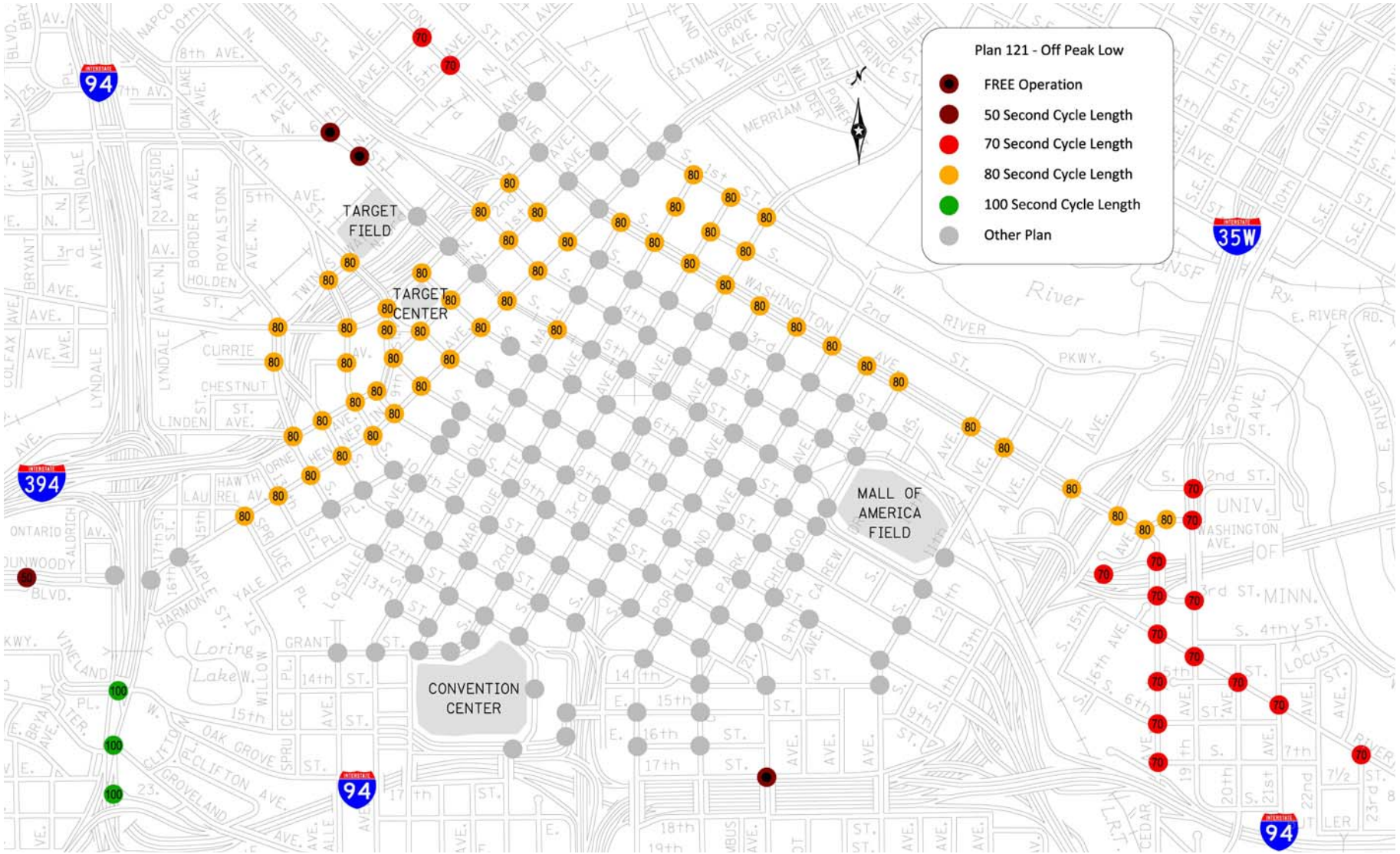


Figure 12. Off Peak Low Plan 121 and Cycle Lengths

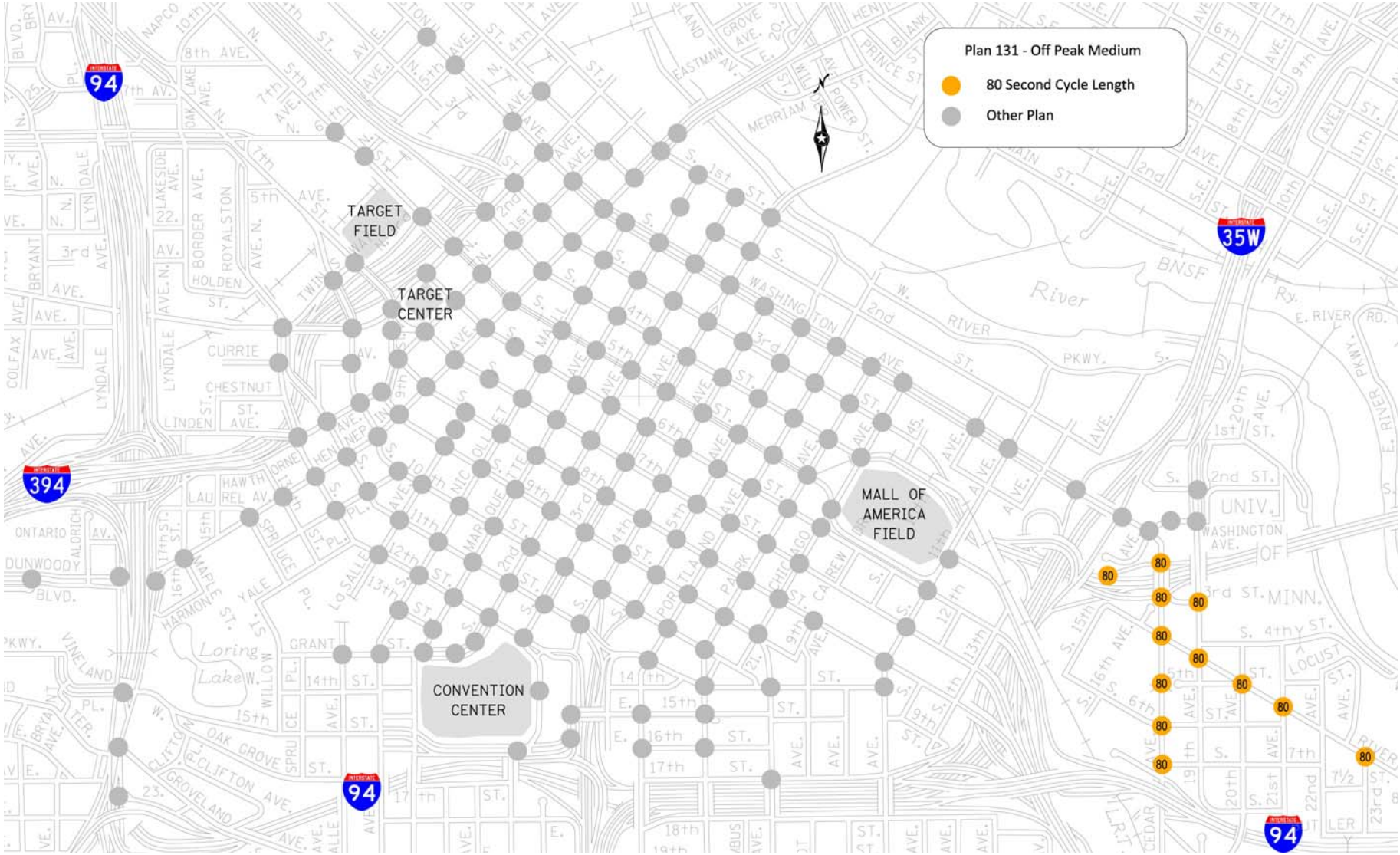


Figure 13. Off Peak Medium Plan 131 and Cycle Lengths

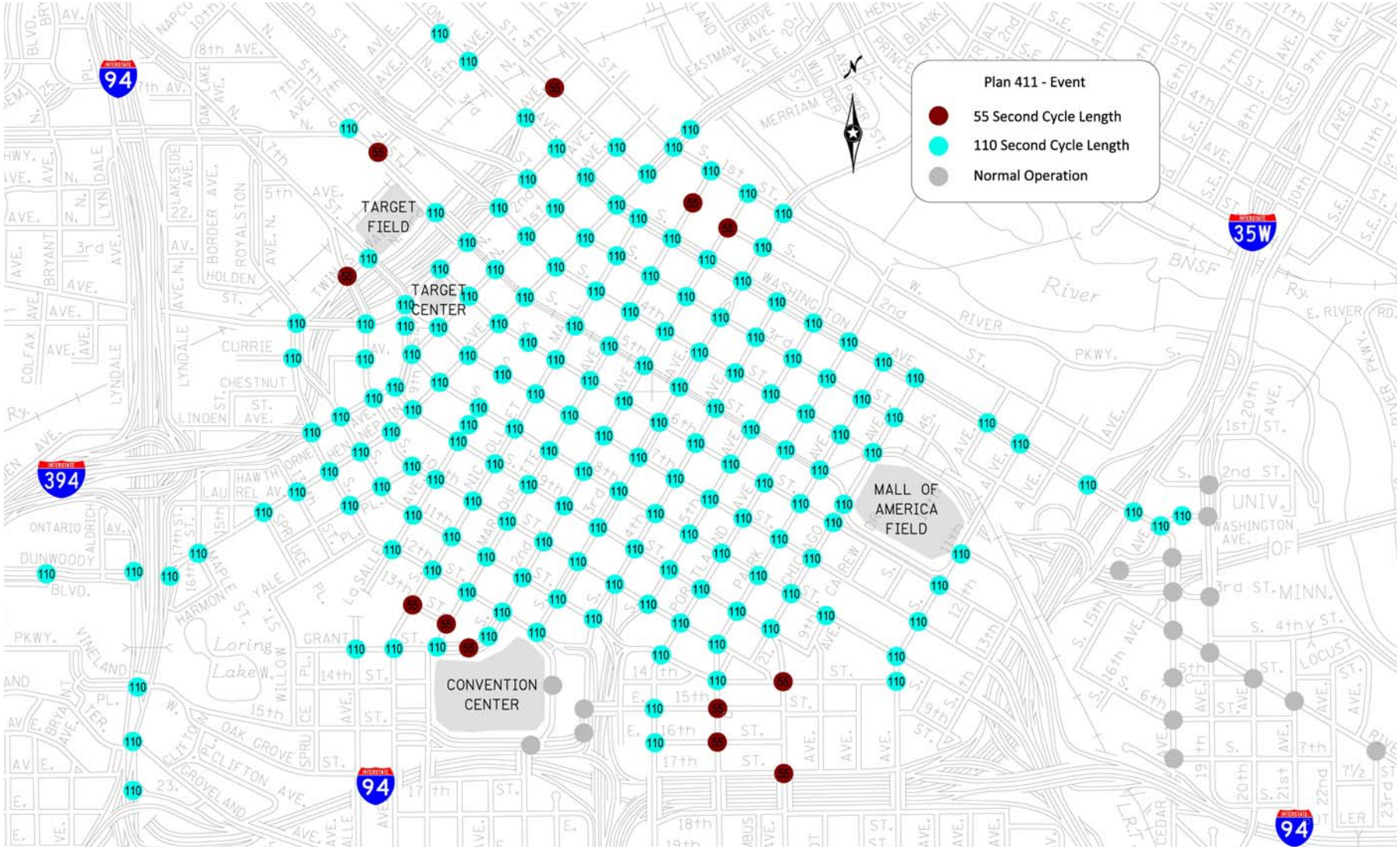


Figure 14. Target Field/Target Center Event Plan and Cycle Lengths

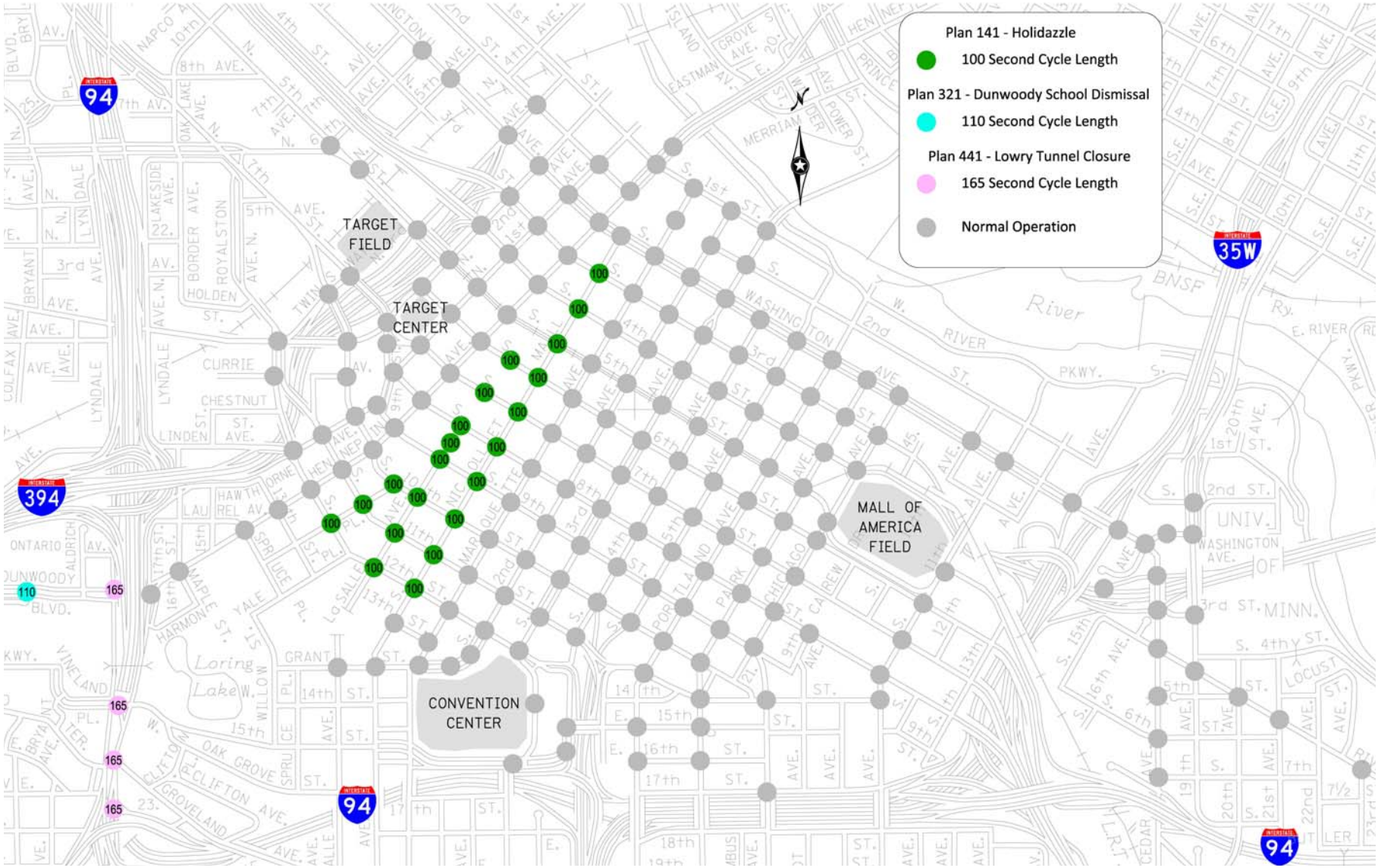


Figure 15. Special Event Timing Plans and Cycle Lengths

3.4 Signal Timing Implementation

The optimized timing plans were programmed into the Tactics Central Management Software and downloaded to the local controllers. The implementation occurred in essentially nine phases between July and December 2013. Alliant Engineering and Minneapolis staff field validated the timing plans and fine-tuned the system to actual traffic conditions. Much of the implementation occurred during the month of July, with the event timing plan reviews occurring in August and the snow plan validation occurring in December. Throughout the fine-tuning process minor refinement of the TOD schedules were also made. Figure 16 documents the implementation schedule and process followed.

3.5 Traffic Operation Analysis

The following section presents the traffic operation analysis results for the optimized timing plans.

3.5.1 Overall Intersection, Transit and Arterial LOS

The approach and overall intersection level of service analysis for the a.m., mid-day and p.m. peak hour existing conditions is documented in Appendix B. A summary of the estimated transit corridor bus delay and passenger delay (assuming an average of 30 passengers per bus) is documented in Table 10. The arterial level of service (measured as average vehicle speed per the HCM) is documented in Table 11. The level of service criteria was previously presented in Table 5.

Table 10. Transit Corridor Overall Delay Summary – Optimized Conditions

Corridor	Transit Corridor		AM Peak Hour		Mid-day Peak Hour		PM Peak Hour	
			Total Bus Delay (hr)	Total Psgr Delay (hr)	Total Bus Delay (hr)	Total Psgr Delay (hr)	Total Bus Delay (hr)	Total Psgr Delay (hr)
2	4th Street Transit Corridor	Existing	3.2	97.5	1.1	33.2	1.9	57.2
		Optimized	2.7	80.5	1.0	29.3	2.6	77.5
3	Nicollet Mall Transit Corridor	Existing	3.0	91.4	1.9	57.9	3.6	106.7
		Optimized	4.5	135.9	1.4	42.1	3.2	97.3
4	Hennepin Avenue Transit Corridor	Existing	6.3	187.8	2.4	72.4	7.4	223.1
		Optimized	3.6	107.5	1.7	51.8	3.8	115.1
5	7th/8th Street Transit Corridor	Existing	3.9	116.1	1.6	48.9	4.4	130.9
		Optimized	3.5	105.7	1.5	44.5	3.8	113.6
6	Marquette/2nd Avenue Transit Corridor	Existing	10.2	307.1	0.8	24.2	11.2	334.9
		Optimized	10.0	299.7	0.7	20.4	9.7	291.8
7	3rd Street Transit Corridor	Existing	0.1	2.2	0.0	1.0	1.3	39.0
		Optimized	0.1	4.2	0.0	1.3	1.0	28.9
8	11th Street Transit Corridor	Existing	0.4	12.2	0.1	2.5	2.5	73.8
		Optimized	0.3	10.4	0.1	1.5	1.8	53.2
All Routes	**All Corridors**	**Existing**	**27.1**	**814.3**	**8.0**	**240.0**	**32.2**	**965.6**
		Optimized	**24.8**	**743.9**	**6.4**	**190.9**	**25.9**	**777.4**
		% Improvement	**8.6%**	**8.6%**	**20.4%**	**20.4%**	**19.5%**	**19.5%**

Note: The transit corridor route number cross-references with Figure 6. The primary corridors are not listed in any particular order of priority.

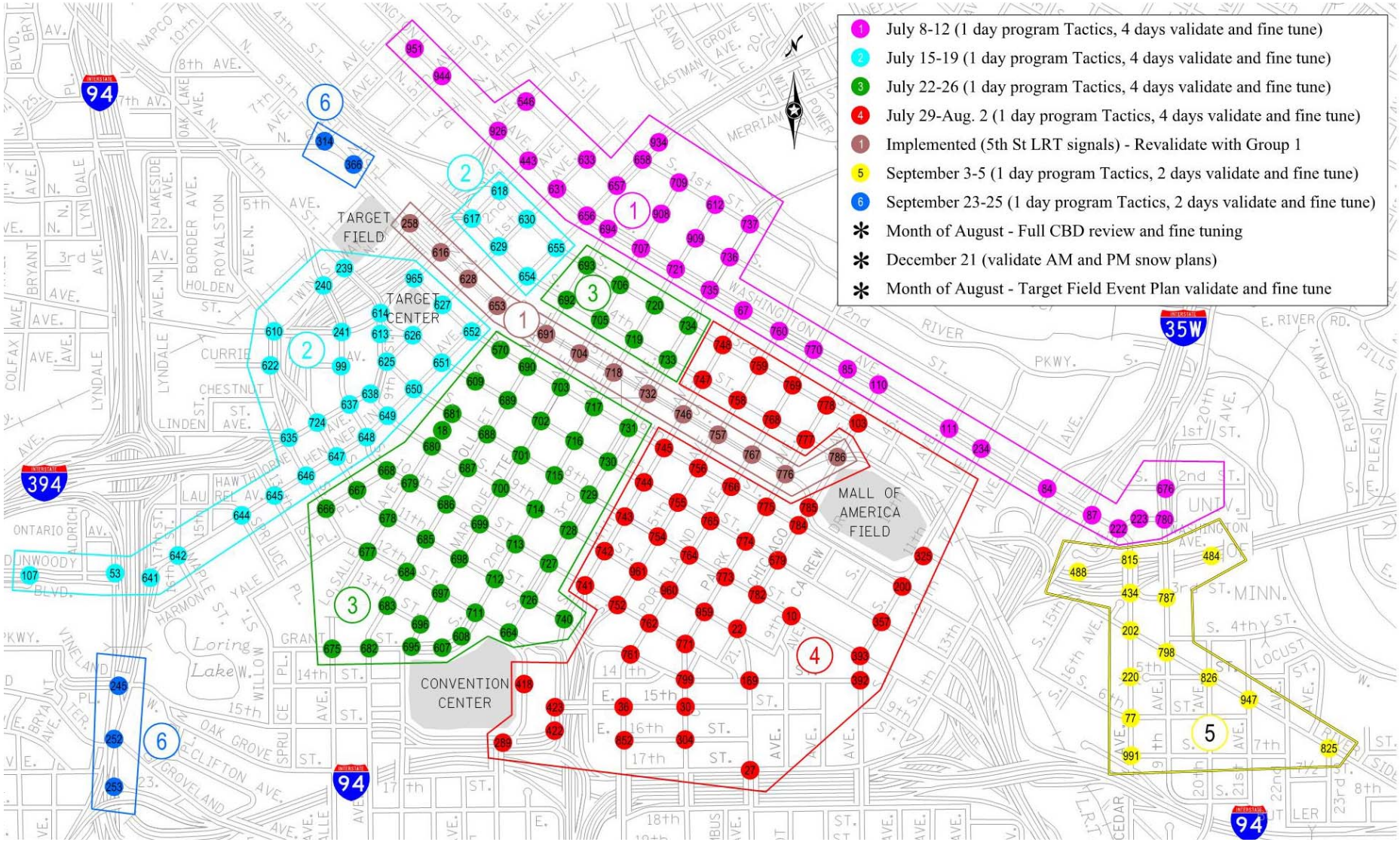


Figure 16. Downtown Retiming Implementation Plan

Table 11. Optimized Arterial Level of Service

Northbound / Eastbound

Route #	Corridor	Existink Condition						Optimized Condition					
		AM Peak		Mid Peak		PM Peak		AM Peak		Mid-Day Peak		PM Peak	
		Averake Travel Speed (mph)1	LOS	Averake Travel Speed (mph)1	LOS	Averake Travel Speed (mph)1	LOS	Averake Travel Speed (mph)1	LOS	Averake Travel Speed (mph)1	LOS	Averake Travel Speed (mph)1	LOS
1	Washinkton Avenue From N 6th Ave To I-35W Nothbound (East Ramp)	10.6	D	12.7	C	6.2	**F**	15.5	C	14.9	C	12.4	D
2	4th Street From N 1st Ave To Chicago Avenue	8.2	**E**	10.5	D	10.3	D	9.8	**E**	9.8	**E**	9.1	**E**
3	6th Street From N 1st Ave To S 11th Ave	7.8	**E**	11.5	D	8.4	**E**	10.9	D	12.7	C	10.7	D
4	8th Street From Hennepin Avenue To S 11th Ave	8.6	**E**	11.5	D	9.6	**E**	10.1	D	10.7	D	9.2	**E**
5	10th Street From Twins Way To Chicago Avenue	7.1	**F**	10.3	D	8.5	**E**	9.1	**E**	9.6	**E**	8.4	**E**
6	1st Avenue From 11th St N To 2nd St N	8.1	**E**	9.1	**E**	6.3	**F**	7.9	**E**	9.4	**E**	6.7	**F**
7	Hennepin Avenue From N Lyndale Ave To 1st St S	8.0	**E**	11.1	D	7.6	**E**	11.4	D	13.5	C	11.3	D
8	Park Avenue From 16th St E To Washington Avenue	11.6	D	12.7	C	11.4	D	10.3	D	12.9	C	11.4	D
9	3rd Avenue From 16th St E To 2nd St SE	8.0	**E**	9.5	**E**	6.5	**F**	9.5	**E**	11.6	D	8.8	**E**
10	5th Avenue From 3rd St S To 9th St S	10.6	D	12.6	C	10.5	D	9.6	**E**	11.4	D	10.9	D
Average of All Corridors		**8.6**	**E**	**11.1**	**D**	**7.9**	**E**	**10.5**	D	**11.8**	D	**9.9**	**E**

Southbound / Westbound

Route #	Corridor	Existing Condition						Optimized Condition					
		AM Peak		Mid Peak		PM Peak		AM Peak		Mid-Day Peak		PM Peak	
		Average Travel Speed (mph)[1]	LOS	Average Travel Speed (mph)[1]	LOS	Average Travel Speed (mph)[1]	LOS	Average Travel Speed (mph)[1]	LOS	Average Travel Speed (mph)[1]	LOS	Average Travel Speed (mph)[1]	LOS
1	Washington Avenue From I-35W Nothbound (East Ramp) To N 6th Ave	9.6	**E**	10.2	D	7.2	**F**	11.8	D	13.3	C	10.8	D
2	3rd Street From Chicago Avenue To 2nd Ave N	10.4	D	11.2	D	9.0	**E**	9.0	**E**	9.7	**E**	8.9	**E**
4	7th Street From S 11th Ave To Twins Way	10.0	**E**	11.4	D	8.6	**E**	9.8	**E**	12.1	D	9.7	**E**
5	9th Street From Chicago Avenue To Hawthorne Avenue	10.3	D	11.5	D	9.1	**E**	8.2	**E**	10.4	D	8.7	**E**
6	1st Avenue From 2nd St N To 12 St N	7.7	**E**	9.5	**E**	7.6	**E**	8.0	**E**	9.0	**E**	8.5	**E**
7	Hennepin Avenue From Robert Fischer Dr To 15th St W	9.3	**E**	9.9	**E**	8.3	**E**	14.3	C	12.9	C	12.8	C
8	Portland Avenue From Washington Avenue To 16th St E	10.8	D	12.4	D	10.9	D	10.5	D	11.9	D	9.7	**E**
9	3rd Avenue From 2nd St S To 14th St E	8.7	**E**	10.1	D	8.6	**E**	8.0	**E**	10.4	D	8.7	**E**
10	4th Avenue From 3rd St S To 10th St S	10.3	D	11.7	D	9.2	**E**	9.5	**E**	11.5	D	8.3	**E**
Average of All Corridors		**9.6**	**E**	**10.7**	**D**	**8.5**	**E**	**9.9**	**E**	**11.3**	D	**9.7**	**E**

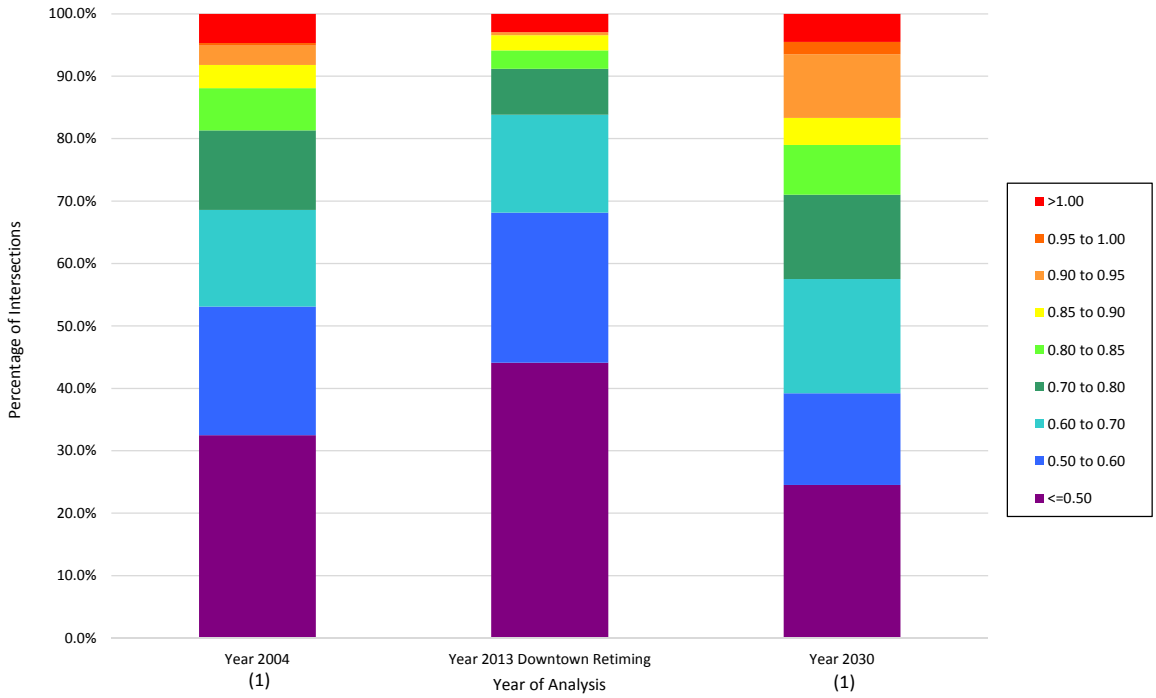
[1] SimTraffic model ouput for AM and PM peak hours. Synchro model output for Mid-day and Saturday scenario.

Table 12 shows a comparison of the overall intersection performance (p.m. peak period) against the targets documented in the Minneapolis Downtown Action Plan. As shown, the Downtown Retiming project completed in 2013 has increased traffic volume throughput within the CBD, resulting in traffic operation conditions better than the 2004 baseline.

3.5.2 Optimized Network Performance Measures

The optimized network performance was evaluated for the a.m. peak, mid-day peak, p.m. peak and remaining off peak periods. Key measures of effectiveness (MOE's) include overall delay (hours), vehicle stops, fuel consumption and air quality emissions (CO, NOx and VOC). Table 13 documents the optimized condition network performance measures.

Table 12. Intersection Performance Target Comparison – Volume to Capacity (PM Peak)



(1) Year 2004 and Year 2030 values based on Access Minneapolis Downtown Action Plan (June 29, 2007), page 34.

Table 13. Optimized Network Performance Measures

	MOE	Existing ("Before")				Optimized ("After")				Percent Reduction			
		AM Peak	Mid-Day Peak	PM Peak	Remaining Off Peak Hours	AM Peak	Mid-Day Peak	PM Peak	Remaining Off Peak Hours	AM Peak	Mid-Day Peak	PM Peak	Remaining Off Peak Hours
Minneapolis - CBD Signals	Stops (no. of veh)	298,031	454,819	407,061	993,478	**231,885**	**371,734**	**329,567**	**816,021**	**28.5%**	**22.4%**	**23.5%**	**21.7%**
	Delay (hr)	2,836	3,383	4,301	7,144	**2,410**	**2,918**	**3,475**	**6,407**	**17.6%**	**15.9%**	**23.8%**	**11.5%**
	Fuel Consumption (gal)	4,431	6,430	6,027	17,655	**3,998**	**5,959**	**5,496**	**16,359**	**10.8%**	**7.9%**	**9.7%**	**7.9%**
	Emission (CO) (kg)	610	973	727	1,240	**565**	**918**	**674**	**1,152**	**7.9%**	**6.0%**	**7.8%**	**7.7%**
	Emission (NOx) (kg)	97	151	116	240	**90**	**141**	**108**	**224**	**8.7%**	**6.6%**	**7.2%**	**7.4%**
	Emission (VOC) (kg)	63	94	84	288	**57**	**88**	**77**	**267**	**11.7%**	**7.1%**	**8.3%**	**7.8%**

AM Peak: 715 to 845 AM
Mid-Day Peak: 1115 AM to 300 PM
PM Peak: 400 PM to 545 PM
Off Peak: 600-715 AM, 845 AM to 1115 AM, 300 PM to 400 PM, 545 PM to 1100 PM

3.5.3 5th Street LRT

A VISSIM model was created for the 5th Street LRT corridor to more accurately replicate and optimize the light rail vehicle operating characteristics, station dwell times and traffic signal operations. The model was calibrated to the existing conditions through the use of video, LRT station inventory data, observations and speed measurements recorded onboard the light rail vehicle. The goal of the timing plan development was to determine the required timing parameters to progress LRT vehicles between stations, with no stops in either direction, given the existing traffic signal, intersection and LRT infrastructure. At a minimum the outbound (southbound) train would be given progression priority, as this is preferred direction by Metro Transit.

The analysis determined that two-way progression, station-to-station, is possible under a 110 second cycle length. The 110 second cycle length plan includes all 5th Street intersections between 3rd Avenue N and Park Avenue to be used with the a.m. peak time period, p.m. peak time period and Target Field event exit. The 100 second (3rd Avenue N to Nicollet Mall) / 80 second cycle length (Marquette Avenue to Park Avenue) plan would be used with the weekday and weekend off peak time periods. Under this plan, the outbound direction is given priority. The 80 second cycle was determined to not be a viable option during the peak periods.

The operation analysis evaluated the average signal delay of the LRT vehicle between the Target Field and Downtown East Stations. Table 14 shows the estimated reduction in signal delay experienced by the LRT vehicle while traveling through the downtown area. It should be noted that the signal delay includes delay incurred to the light rail vehicle following the station dwell time (closing of doors) and waiting for the station signal to turn green. The

actual route travel time savings are presented in the Project Benefits (Section 4.3) of this report.

Table 14. LRT Signal Delay Comparison

Outbound (Southbound)

	PM Peak (4:30 p.m. to 5:30 p.m.)			MID Peak (12:30 p.m. to 1:30 p.m.)			AM Peak (7:30 a.m. to 8:30 a.m.)		
	Existing Conditions	Optimized (110 s)	% Improvement	Existing Conditions	Optimized (100/80 s)	% Improvement	Existing Conditions	Optimized (110 s)	% Improvement
	Signal Delay (s)	Signal Delay (s)		Signal Delay (s)	Signal Delay (s)		Signal Delay (s)	Signal Delay (s)	
Target Field Station to Hennepin Avenue Station	98.9	48.8	**51%**	68.4	61.3	**10%**	90.6	53.5	**41%**
Hennepin Avenue Station to Nicollet Mall Station	29.8	25.7	**14%**	37.6	19.6	**48%**	56.6	20.9	**63%**
Nicollet Mall Station to Government Plaza Station	39.9	50.9	**-28%**	33.9	47.6	**-41%**	106.6	50.1	**53%**
Government Plaza Station to Downtown East Station	54.2	23.5	**57%**	62.0	57.7	**7%**	59.9	27.2	**55%**
Target Field Station to Downtown East Station	**222.7**	**148.9**	**33%**	**202.0**	**186.1**	**8%**	**313.7**	**151.7**	**52%**

Inbound (Northbound)

	PM Peak (4:30 p.m. to 5:30 p.m.)			MID Peak (12:30 p.m. to 1:30 p.m.)			AM Peak (7:30 a.m. to 8:30 a.m.)		
	Existing Conditions	Optimized (110 s)	% Improvement	Existing Conditions	Optimized (100/80 s)	% Improvement	Existing Conditions	Optimized (110 s)	% Improvement
	Signal Delay (s)	Signal Delay (s)		Signal Delay (s)	Signal Delay (s)		Signal Delay (s)	Signal Delay (s)	
Downtown East Station to Government Plaza Station	67.4	29.2	**57%**	111.3	75.3	**32%**	44.1	20.7	**53%**
Government Plaza Station to Nicollet Mall Station	76.8	16.2	**79%**	83.3	71.6	**14%**	27.1	23.5	**13%**
Nicollet Mall Station to Hennepin Avenue Station	32.2	58.4	**-82%**	43.6	38.3	**12%**	17.5	20.8	**-19%**
Hennepin Avenue Station to Target Field Station	57.1	69.1	**-21%**	57.5	65.4	**-14%**	59.1	56.7	**4%**
Downtown East Station to Target Field Station	**233.5**	**172.9**	**26%**	**295.7**	**250.6**	**15%**	**147.8**	**121.7**	**18%**

Currently the 5th Street/Park Avenue S and Marquette Avenue S signals operate with a pre-timed LRT phase. This is necessary to ensure the bar signal is active and held for the train arriving into the station. However, intersection capacity and efficiency at these intersections could be greatly improved through the installation of advanced LRT detection, as listed below:

- Southbound/eastbound direction: Install an advanced detector at the City Hall station (locate at 4th Avenue) to call the LRT phase at Park Avenue.
- Northbound/westbound direction: Install an advanced detector at the City Hall station (locate at 3rd Avenue) to call the LRT phase at Marquette Avenue.

3.5.4 Marquette Avenue/2nd Avenue Bus Operations

A VISSIM analysis was completed for the Marquette Avenue/2nd Avenue bus corridors to evaluate and fine tune the optimized peak hour timing plans. The VISSIM model included all Metro Transit bus routes and schedules and was calibrated in accordance with; the bus station field inventory observations and data, speed study data, field observations and the Metro

Transit Standard Operating Procedure for the Marquette Avenue and 2nd Avenue transit lanes. The purpose of the detailed evaluation is to test various timing strategies, analyze the performance of the optimized timing plans; and to compare the optimized timing against the existing conditions to estimate the expected change in signal delay. Key conclusions from the field observations and VISSIM evaluation include:

- The optimum timing strategy for Marquette Avenue and 2nd Avenue was found by lining up the beginning of green time along the corridors such that a bus pulling out of the bus stop makes the green light at the next downstream signal (similar to simultaneous green operation). This strategy also benefits the passenger cars traveling in the opposite direction on the two way streets.
- Bus operations benefit by providing the greatest amount of green time to Marquette and 2nd Avenues. However, the amount of green time that can be provided needs to be balanced with the cross-streets (e.g., 3rd Street, 7th Street, etc.).
- The overall corridor bus travel time is a function of the cycle length. A shorter cycle length is likely to produce a shorter travel time (i.e., higher average speed). However, the incremental change is marginal and does not offset the impact that results from having a non-matching cycle length with the remaining CBD.
- Bus weaving, variable station dwell time, and oversaturation of buses per block limits the performance of the corridor. Frequently, too many buses (i.e., full block) will concurrently arrive, which results in congestion.
- The traffic management at the IDS Center (7th Street to 8th Street block) parking access frequently disrupts the bus and vehicle flow, which impacts the bus operation and adds delay.

Table 15 provides a summary of the estimated change in total bus delay (and passenger delay) between the existing conditions and the optimized peak hour timing plans. The analysis found that the optimized timing plans are expected to slightly reduce the overall signal delay, but largely remain about the same as the existing conditions. This finding is based on the fact that the Marquette Avenue/2nd Avenue corridors were recently optimized in 2009 and had good performance. However, the 2009 optimization was completed in isolation and did not consider the larger context of the CBD operation. The Downtown Retiming Project aimed to maintain the Marquette Avenue/2nd Avenue performance (refine the performance where possible) but to better integrate the corridors into the rest of the CBD. The evaluation results show a slight increase in transit performance as expected and now help provide a significant improvement to the east-west travel streets.

Table 15. Marquette/2nd Avenue Signal Delay Comparison

Route	Bus Route Numbers	Total Bus Delay (Hr)		Total Psgr Delay (Hr) [1]	
		EXIST	OPT	EXIST	OPT
SB Marquette - Washington to 11th	747, 825, 672, 673, 675, 824	3.3	**3.3**	98.7	**97.9**
SB Marquette - Washington to 12th	250, 261, 264, 270, 288, 465, 475, 535, 578, 684	1.1	**1.0**	34.1	**29.1**
SB Marquette - 4th to 11th	760, 761, 762, 766, 767, 780	1.7	**1.4**	50.8	**42.7**
SB Marquette - 4th to 12th	781, 783, 785	1.6	**1.4**	49.0	**41.3**
NB 2nd - 12th to Washington	250, 747, 772, 776, 777, 790, 793, 852, 865, 587, 589, 664, 667, 668, 670, 671, 672, 673, 674, 675, 677, 756	6.9	**6.3**	206.4	**190.4**
NB 2nd - 11th to Washington	464, 765, 766	7.8	**7.9**	234.6	**235.9**
Total		22.5	**21.2**	673.5	**637.4**

PM Peak Hour

Route	Bus Route Numbers	Total Bus Delay (Hr)		Total Psgr Delay (Hr) [1]	
		EXIST	OPT	EXIST	OPT
SB Marquette - Washington to 11th	490, 747, 772, 774, 776, 777, 790, 793, 795, 587, 589, 664, 667, 668, 670, 671, 672, 673, 674, 675, 677, 756, 690, 692, 698, 699	11.7	**12.1**	350.0	**361.6**
SB Marquette - Washington to 12th	133, 135, 156, 554, 558, 250, 264, 460, 464, 470, 472, 476, 477, 478, 479, 146, 467, 535, 552, 553, 578, 597	9.6	**8.9**	287.1	**265.7**
SB Marquette - 4th to 11th	766	0.7	**0.6**	21.8	**18.5**
SB Marquette - 4th to 12th [2]	NA	0.6	**0.5**	17.2	**15.0**
NB 2nd - 12th to Washington	760, 761, 762, 763, 767, 250, 261, 263, 264, 270, 288, 742, 747, 825, 850, 852, 854, 865, 588, 672, 675, 780, 781, 782, 783, 785	6.7	**6.2**	201.1	**187.2**
NB 2nd - 11th to Washington	824, 766, 768	5.7	**5.9**	170.2	**177.4**
Total		34.9	**34.2**	1047.5	**1025.4**

1. Assumes a constant 30 passenger average occupancy per bus

2. Route selected to balance out bus routes within VISSIM model

Source: VISSIM Analysis (Average of 5 random seeds)

4.0 Project Benefit Analysis

This section documents the estimated benefit of the Downtown Retiming Project through comparing the performance of the optimized timing plans against the existing conditions and the key project goals. To assess the project benefit, several measures of effectiveness (MOE) are compared, which include; passenger vehicle travel times, LRT travel time, primary bus corridor travel time, total network performance, and a benefit/cost analysis to evaluate the overall cost-effectiveness of the optimized signal timing plans. Key findings in comparison to the four project goals

4.1 Pedestrian Benefit

As part of the project, the pedestrian clearance intervals (walk and don't walk) were reevaluated. The pedestrian times were developed to meet the current provisions of the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD). Pedestrians benefit by being given more opportunity to cross the street on the walk and adequate time to finish crossing on the flashing don't walk. Nearly all of the traffic signals in downtown are pre-timed. The walks are programmed to be activated every cycle (without pushing a button) and are set to rest in the walk indication for the duration of the concurrent vehicle green indication. The flashing don't walk will begin and time out as the adjacent green indication turns to yellow. Under this operation, the pedestrians are given the greatest amount of opportunity to legally enter and cross the street. A comparison of the existing pedestrian clearance intervals to the proposed clearance intervals found a 17 percent increase in pedestrian crossing time.

4.2 Passenger Vehicle Travel Time Comparison

Travel time studies were field collected during both the "before" and "after" conditions throughout the Downtown. The travel time study routes are illustrated in Figure 17. The studies were conducted during the a.m. peak period (7:00 to 9:00 a.m.), mid day (11:30 a.m. to 1:30 p.m.) and p.m. peak period (3:00 to 6:00 p.m.) over multiple weekdays and weeks for both the before and after conditions.

Table 16 provides an overall network comparison of the total travel time collected on all Downtown blocks. Because the Downtown is a grid network, there are trade-offs, reprioritization of streets and balancing that occurs, but an overwhelming number of the blocks (approximate 70 percent) were found to either remain the same or were improved. Overall the Downtown network found an average 14 percent improvement in vehicle travel time.

Table 17, Table 18 and Table 19 illustrate the overall before and after travel time for each route collected during the a.m., mid-day and p.m. peak periods, respectively.

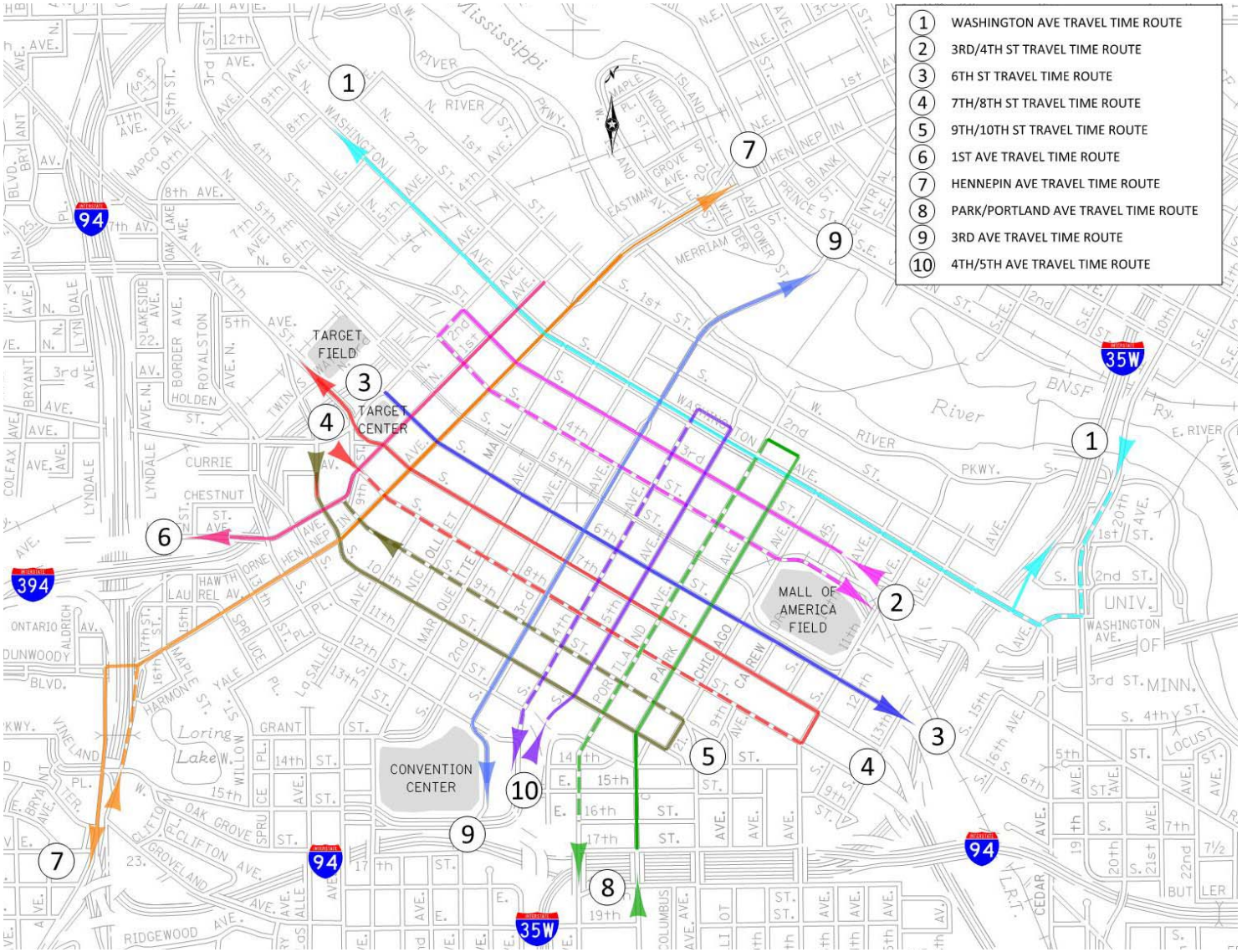


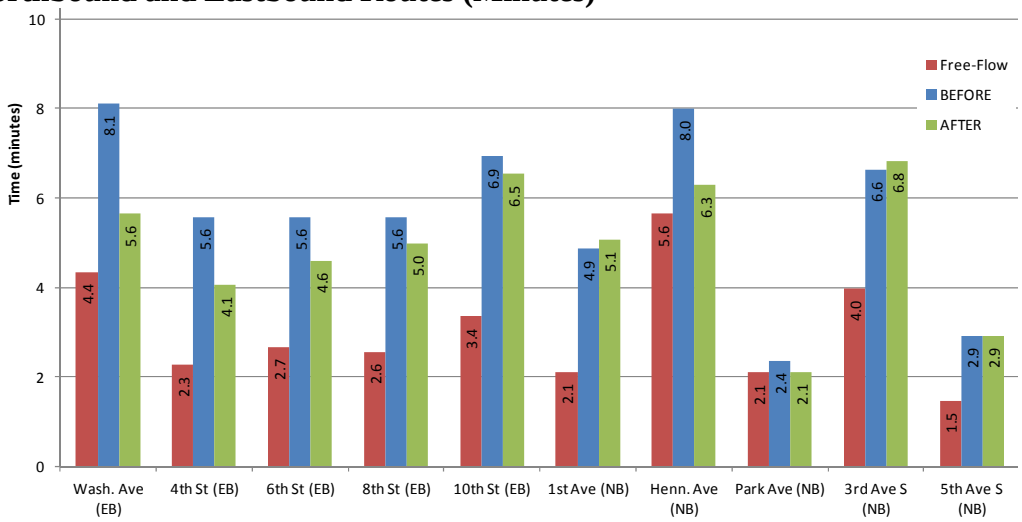
Figure 17. Passenger Vehicle Travel Time Study Routes

Table 16. Overall Downtown Network Travel Time Summary (Minutes)

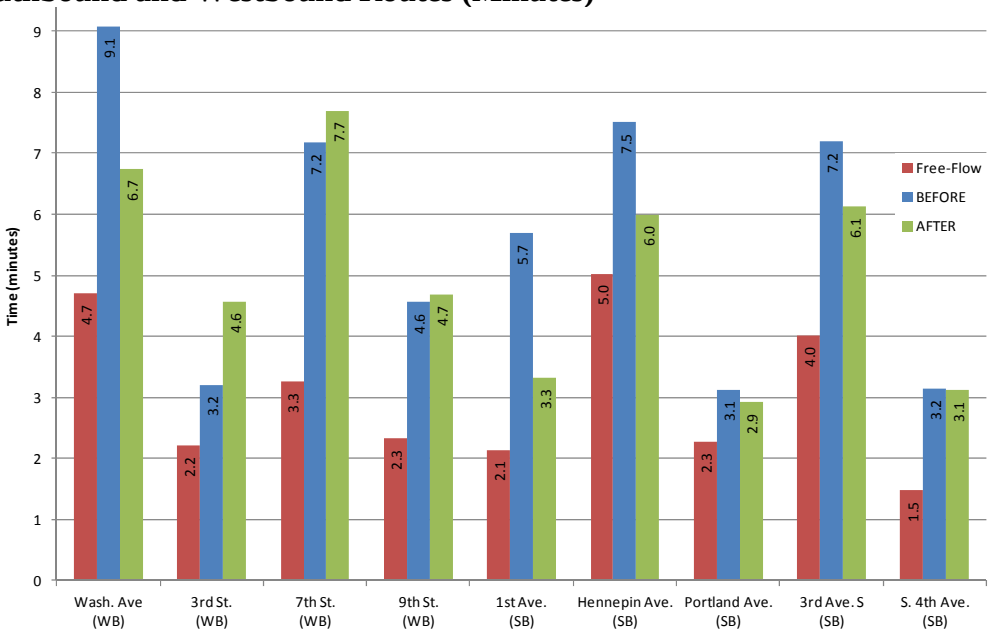
	AM Peak Period		Mid-Day Peak Period		PM Peak Period		All Day
	Peak Hour Average	Overall Average	Peak Hour Average	Overall Average	Peak Hour Average	Overall Average	
	730-830	700-900	1230-130	1130-130	430-530	300-600	
Before Travel Time (All Routes)	111	107	96	95	135	123	**668**
After Travel Time (All Routes)	97	94	86	87	109	100	**573**
Percent Improvement	**13%**	**12%**	**10%**	**9%**	**19%**	**19%**	**14%**

Table 17. Route Travel Time Comparison – AM Peak Period

Northbound and Eastbound Routes (Minutes)



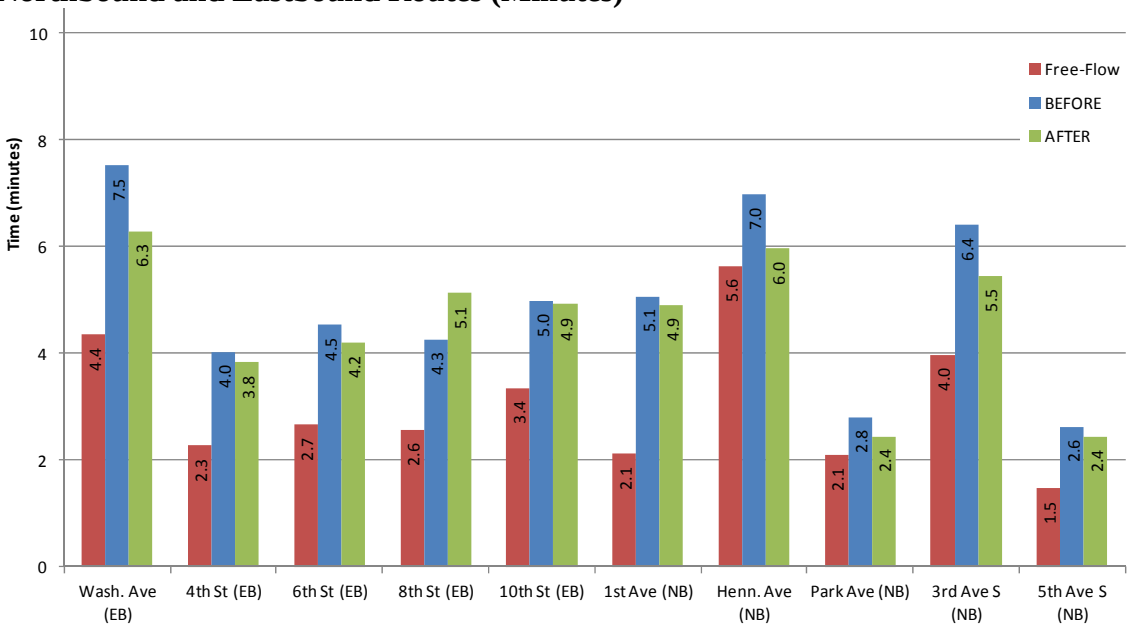
Southbound and Westbound Routes (Minutes)



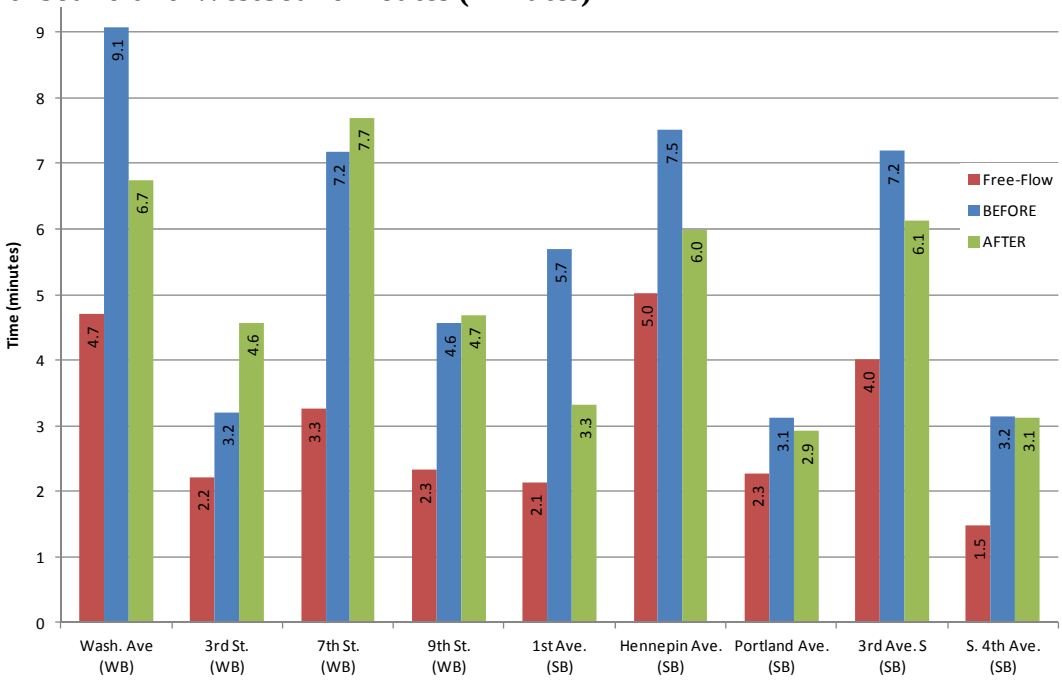
*Before data collected in May and June 2011 by On Call Staffing
*After data collected in September and October 2013 by Alliant Engineering

Table 18. Route Travel Time Comparison – Mid Day Peak Period

Northbound and Eastbound Routes (Minutes)



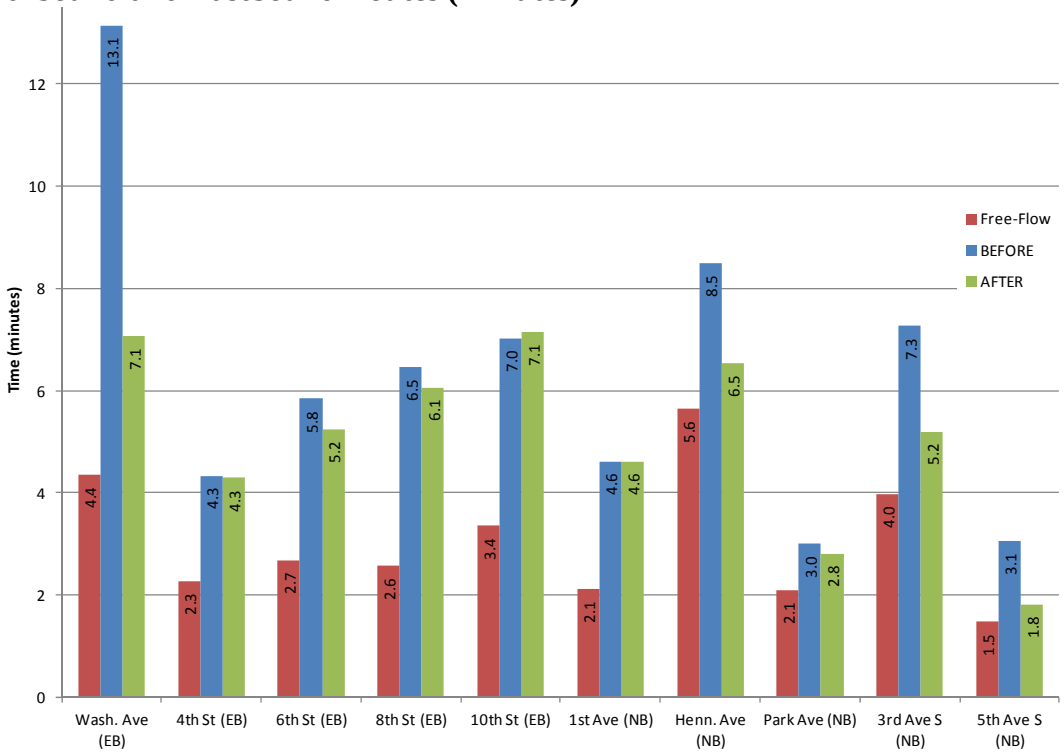
Southbound and Westbound Routes (Minutes)



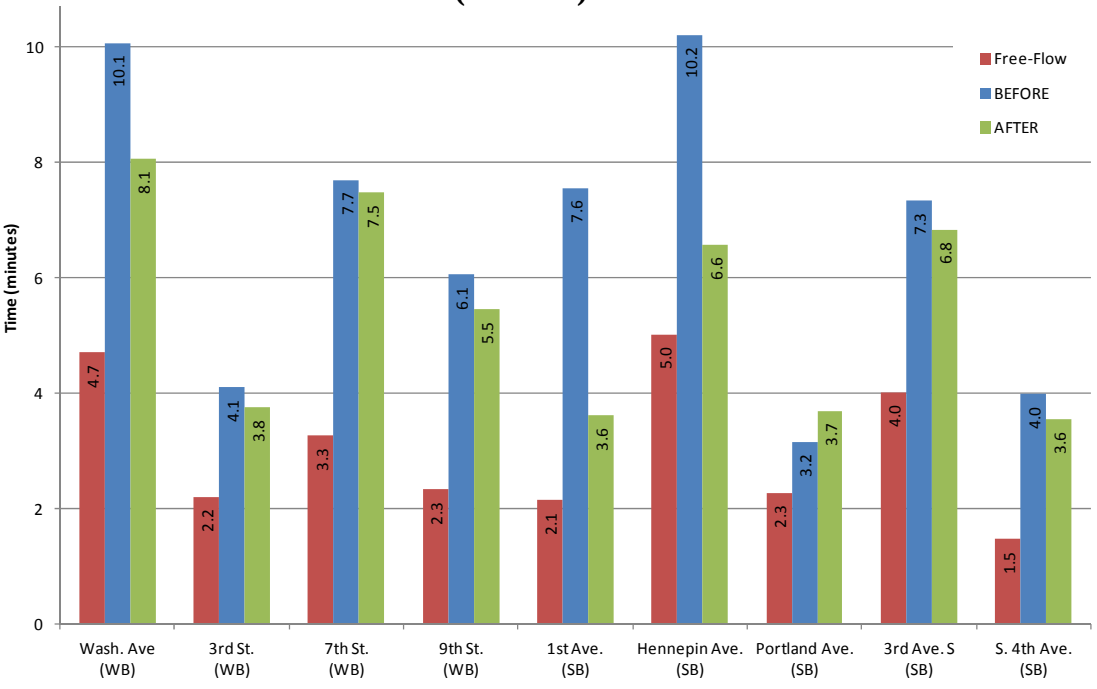
*Before data collected in May and June 2011 by On Call Staffing
*After data collected in September and October 2013 by Alliant Engineering

Table 19. Route Travel Time Comparison – PM Peak Period

Northbound and Eastbound Routes (Minutes)



Southbound and Westbound Routes (Minutes)



*Before data collected in May and June 2011 by On Call Staffing
*After data collected in September and October 2013 by Alliant Engineering

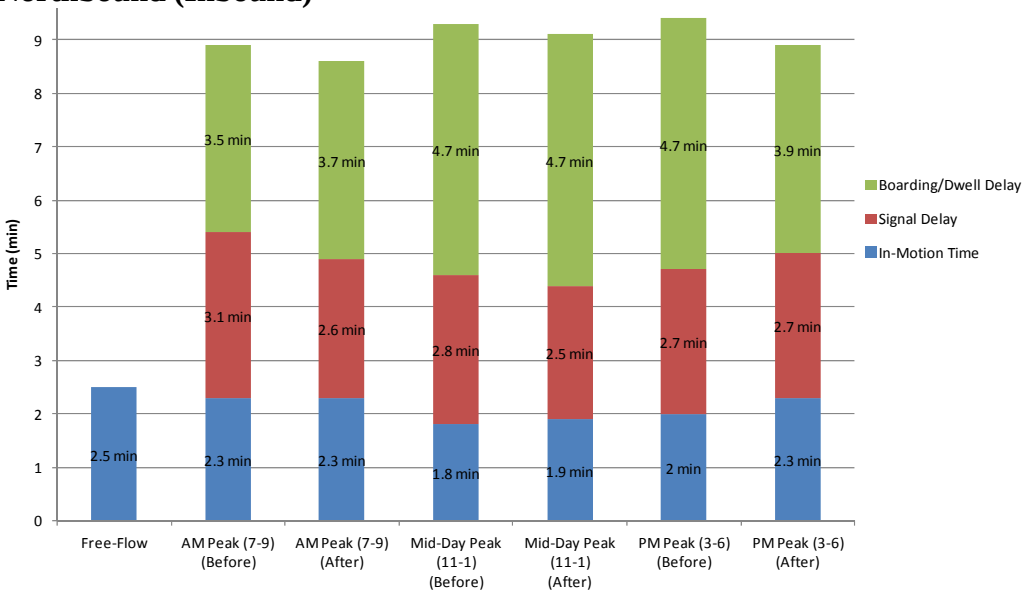
4.3 Metro Transit LRT and Bus Travel Time Comparison

Travel time studies were field collected for the LRT line and primary bus routes traveling through Downtown during both the "before" and "after" conditions. The primary transit travel time study routes are illustrated in Figure 18. The time studies were conducted during the a.m. peak period (7:00 to 9:00 a.m.), mid day (11:30 a.m. to 1:30 p.m.) and p.m. peak period (3:00 to 6:00 p.m.) over multiple weekdays for both the before and after conditions. Data was collected on board the transit vehicles and consisted of recording the in-motion time, signal delay and station dwell delay.

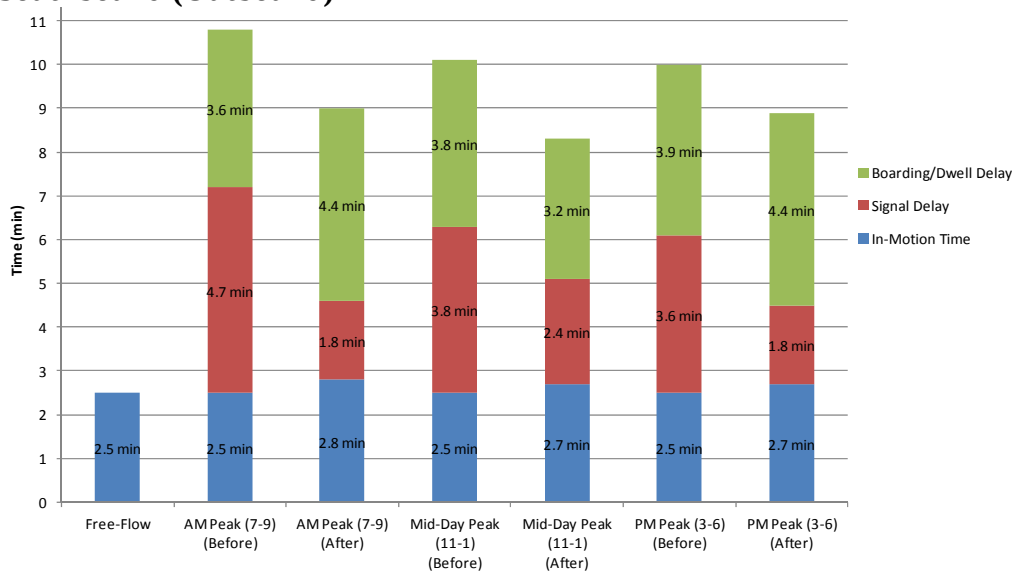
Table 20 through Table 27 illustrate the overall before and after travel time for each route collected during the a.m., mid-day and p.m. peak periods, respectively

Table 20. LRT Blue Line Travel Time Comparison

Northbound (Inbound)



Southbound (Outbound)



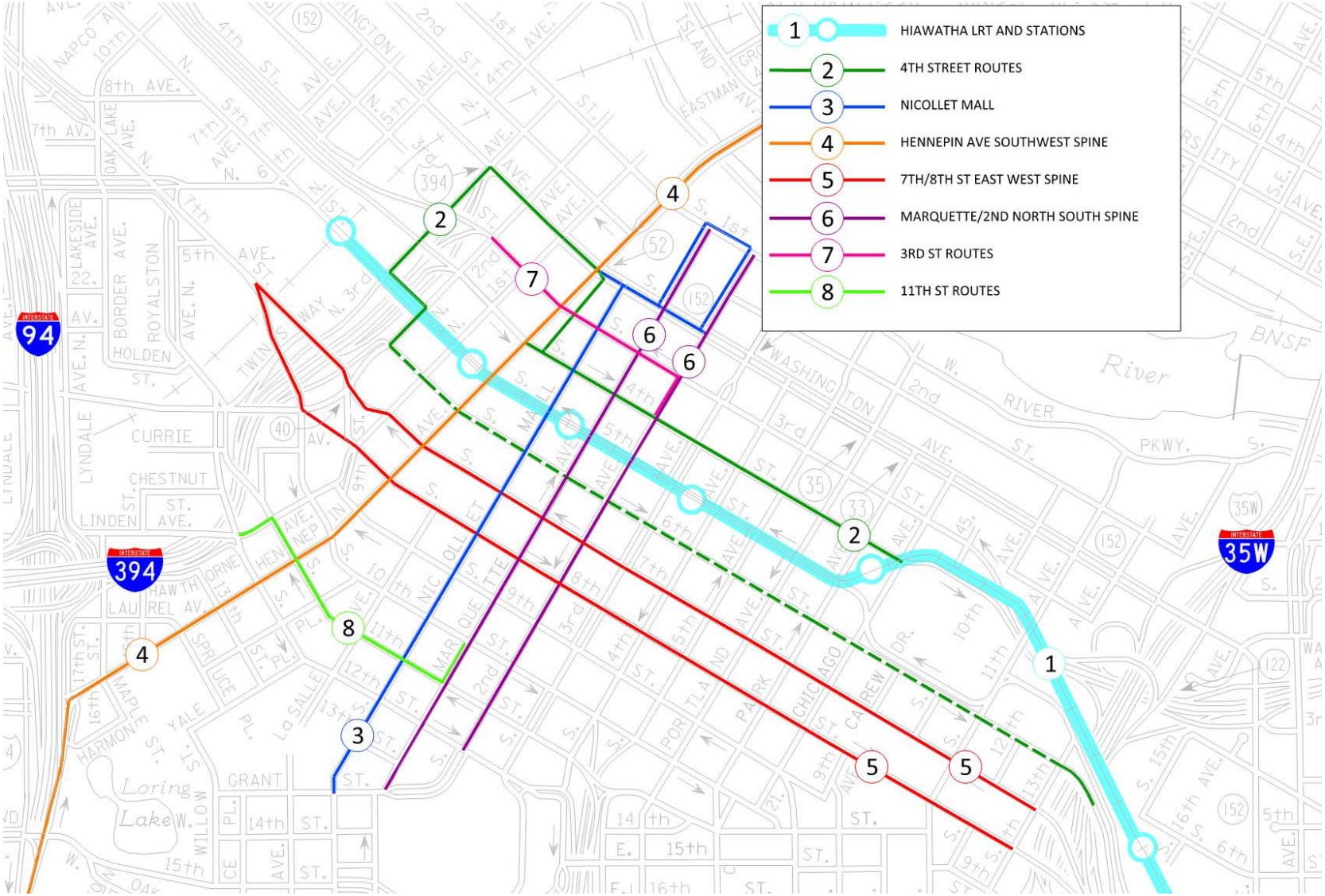
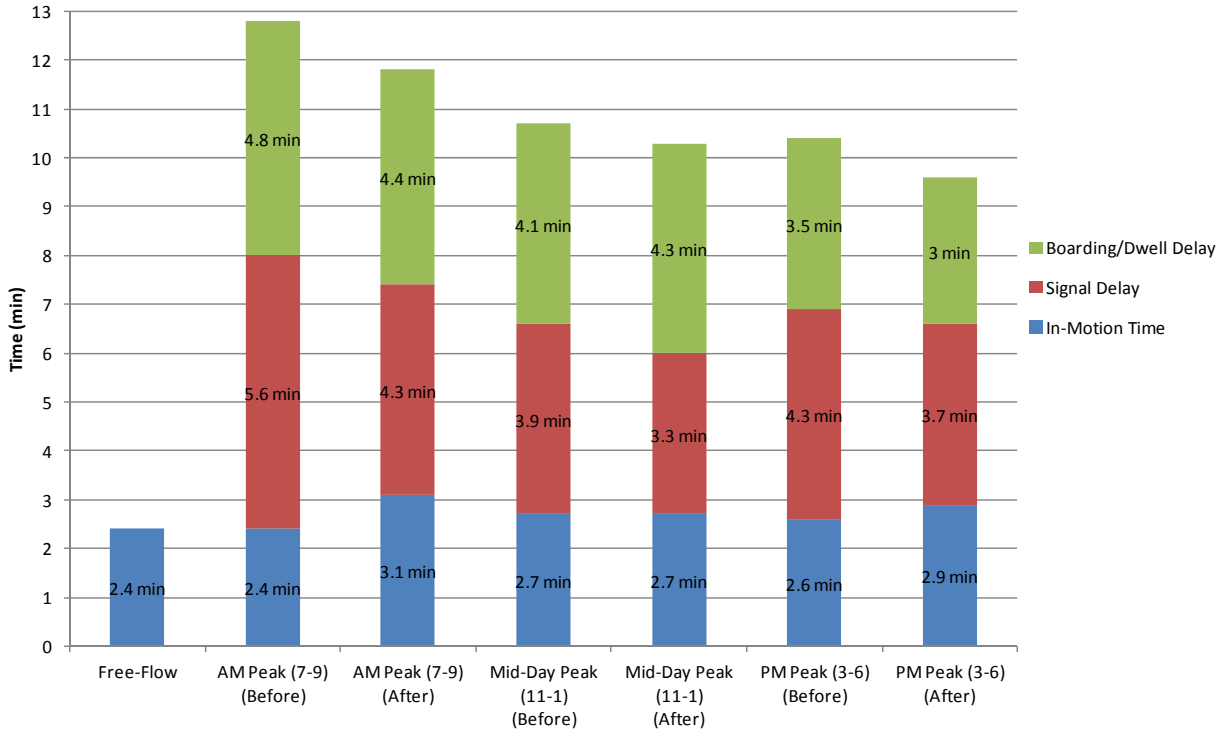


Figure 18. Primary Transit Travel Time Study Routes

Table 21. 4th Street Bus Travel Time Comparison

Eastbound



Westbound

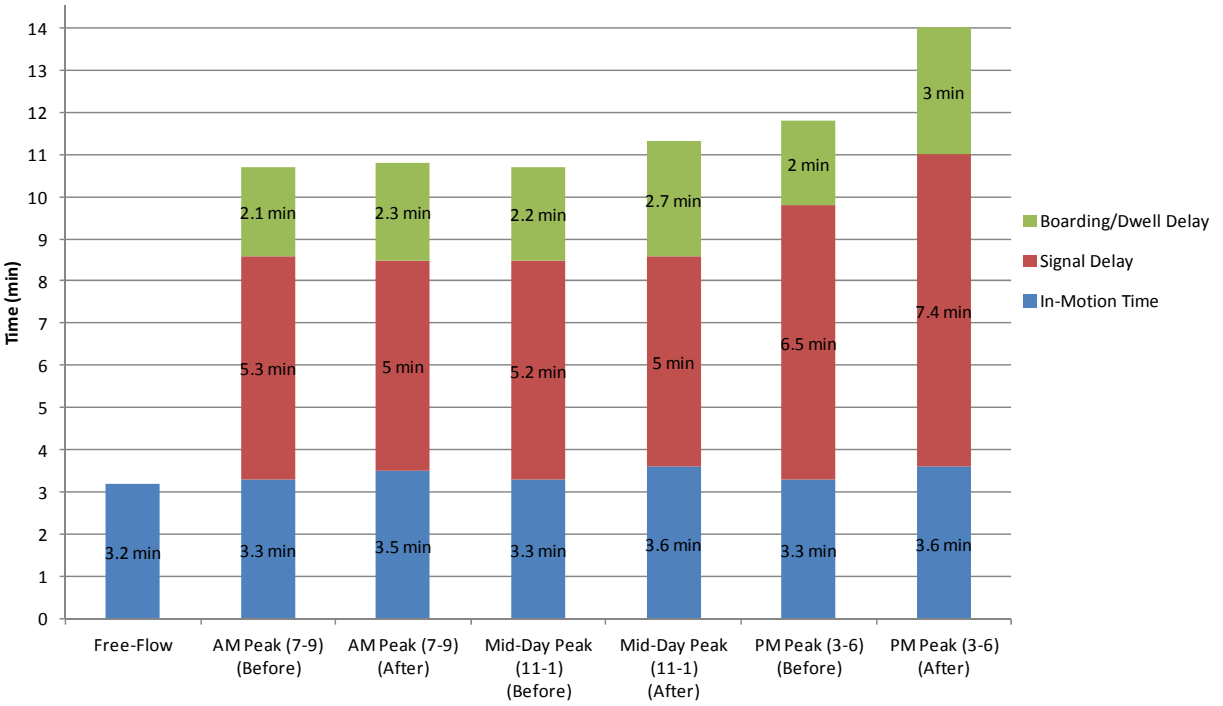
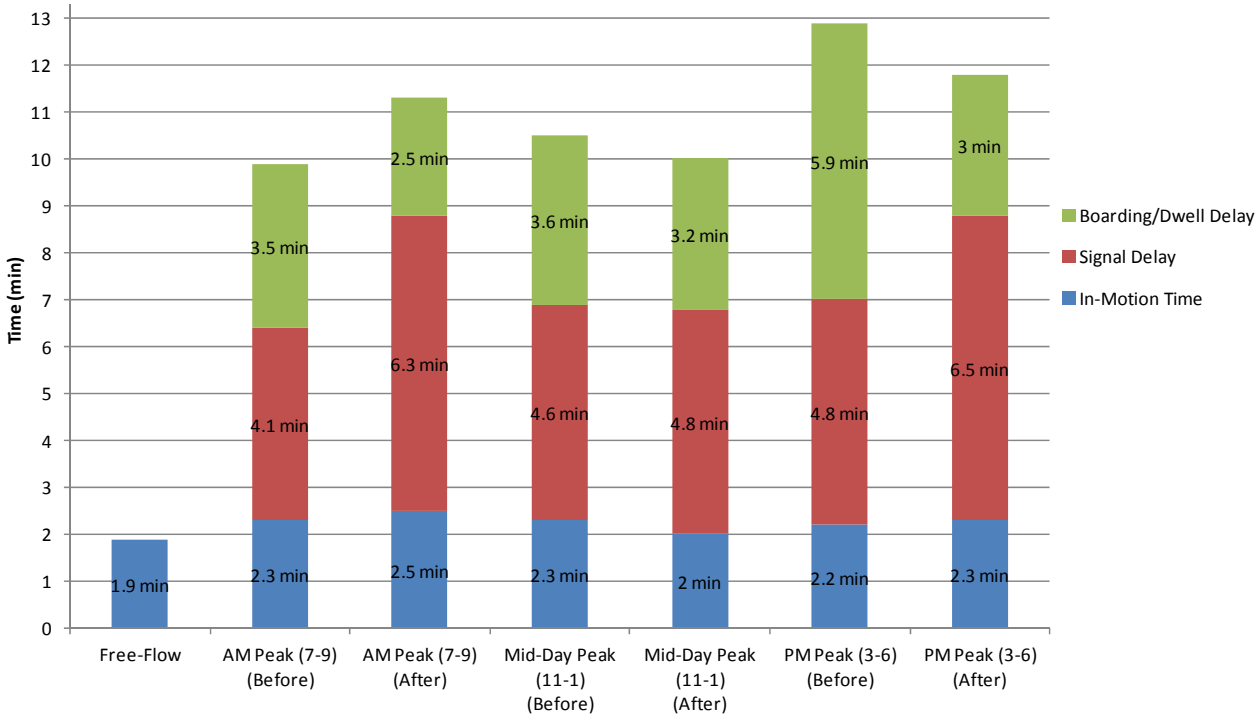


Table 22. Nicollet Mall Bus Travel Time Comparison

Northbound



Southbound

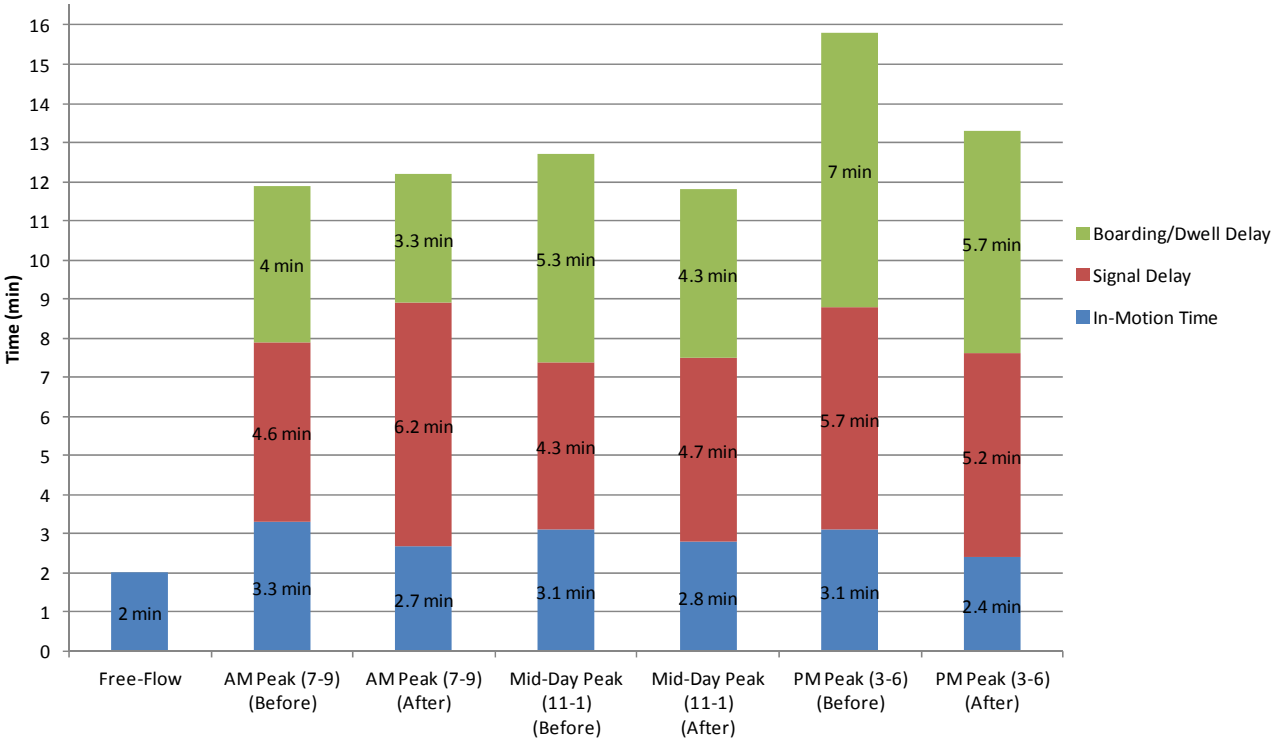
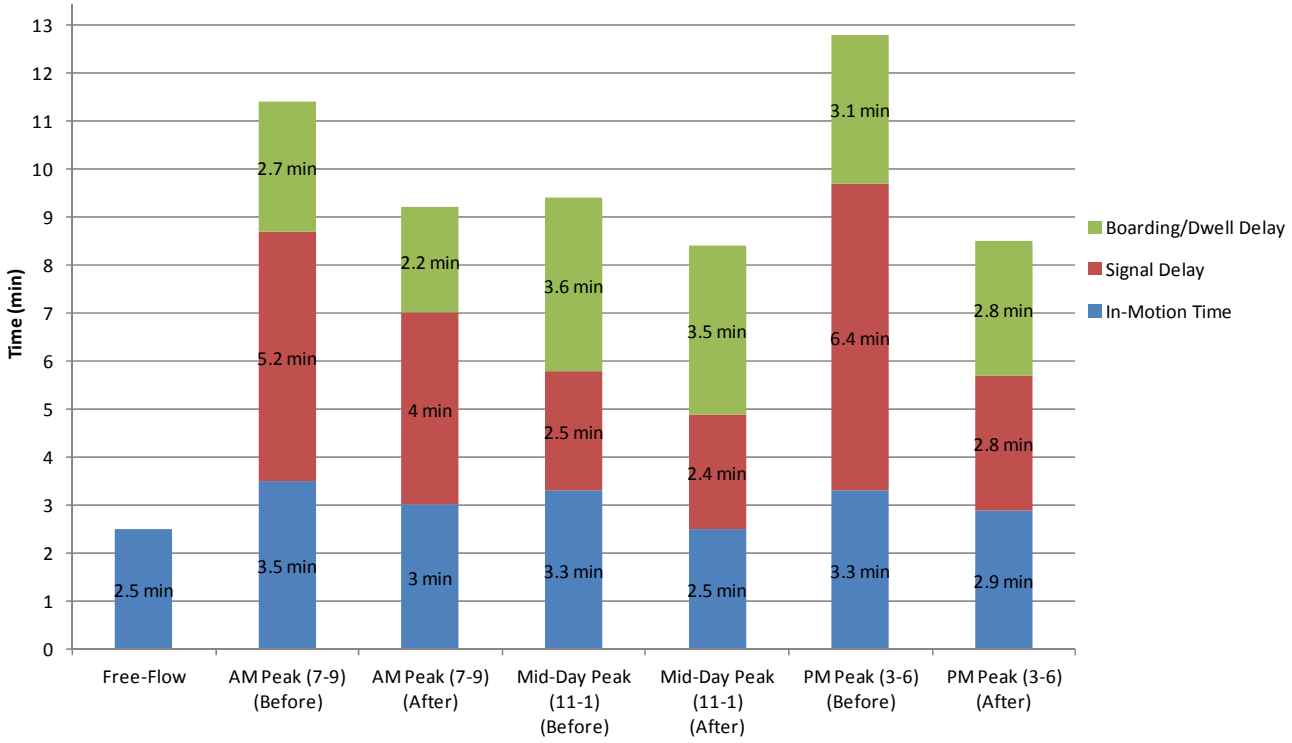


Table 23. Hennepin Avenue Bus Travel Time Comparison

Northbound



Southbound

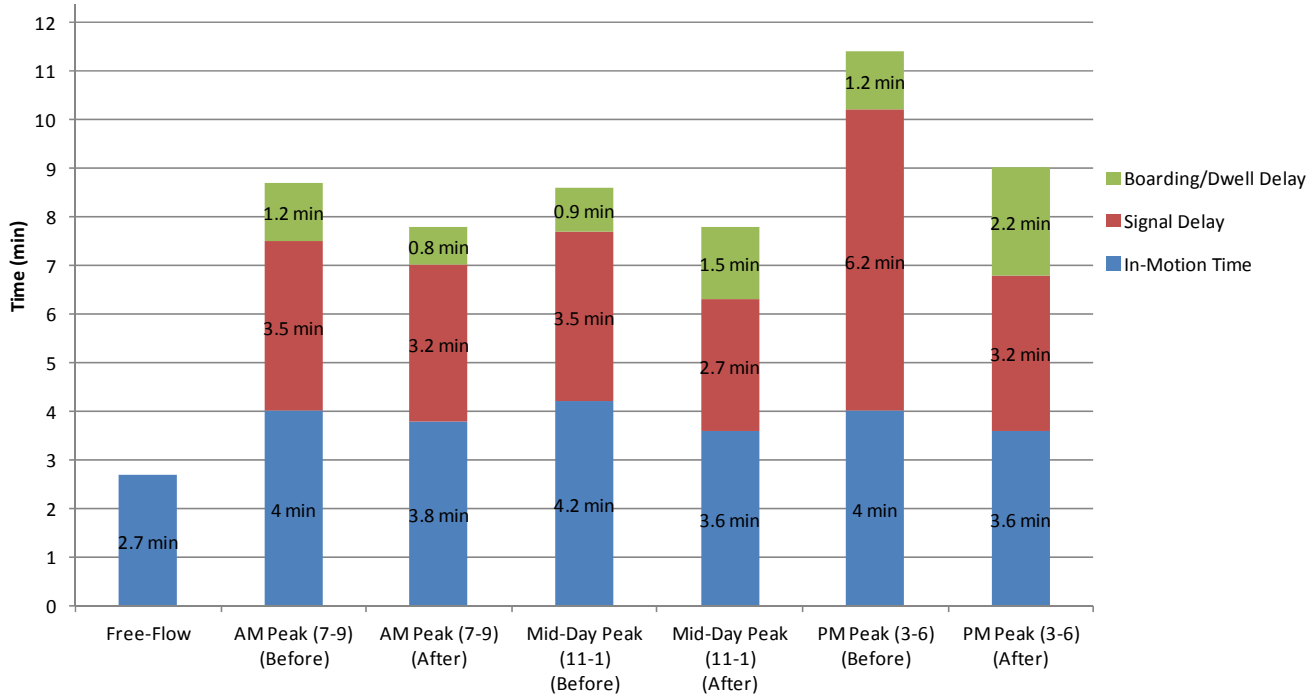
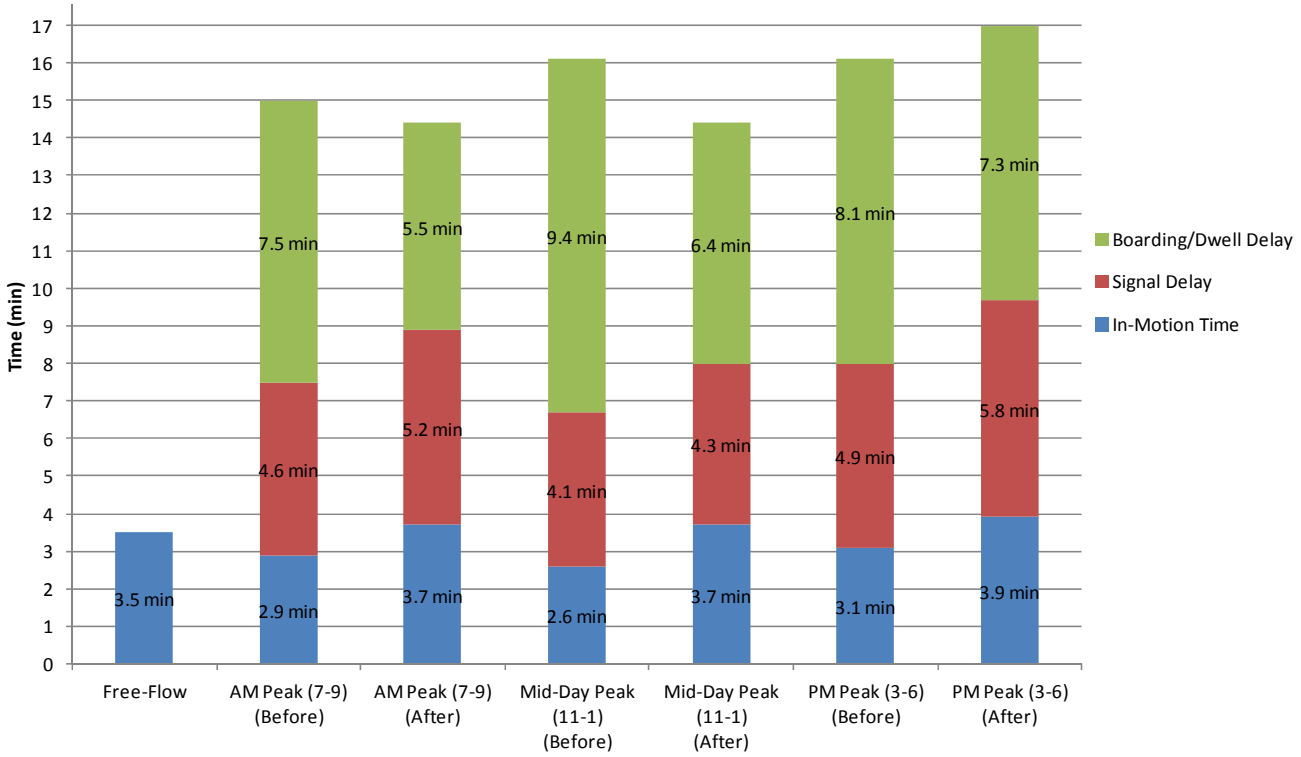


Table 24. 7th Street / 8th Street Bus Travel Time Comparison

Eastbound 8th Street



Westbound 7th Street

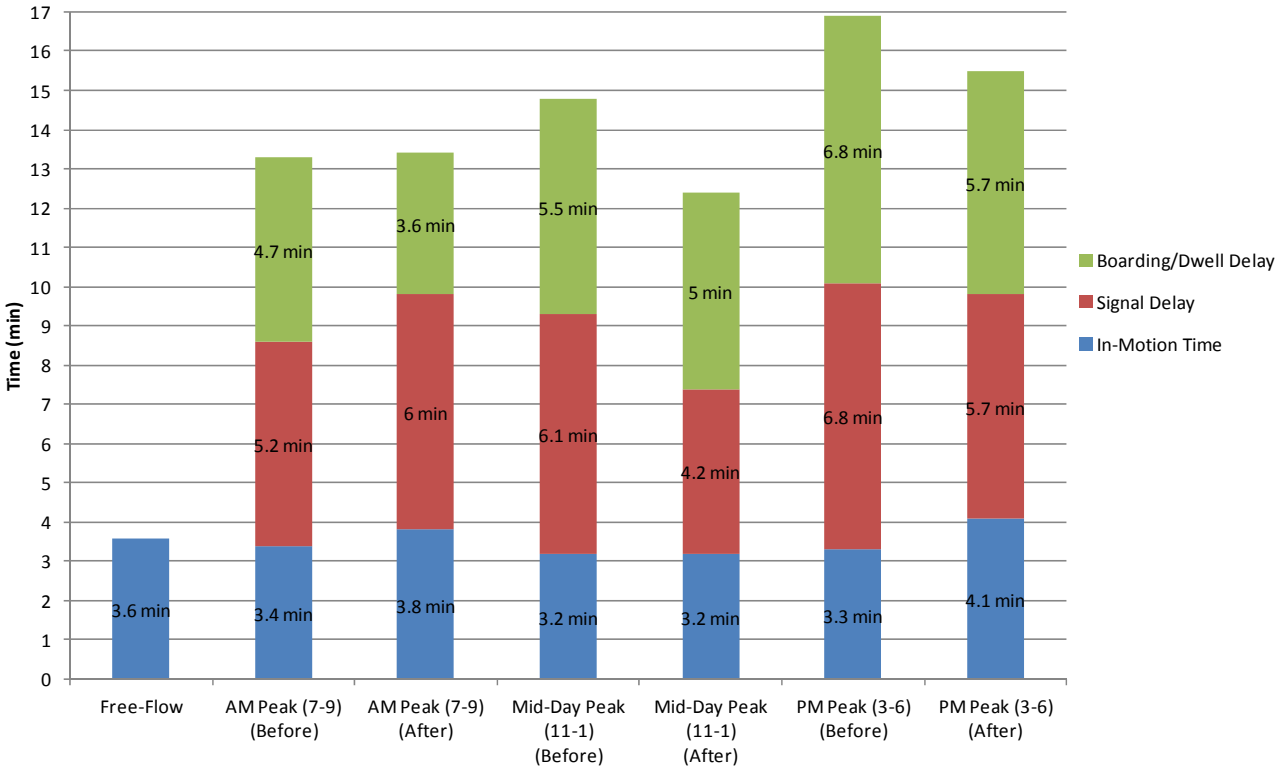
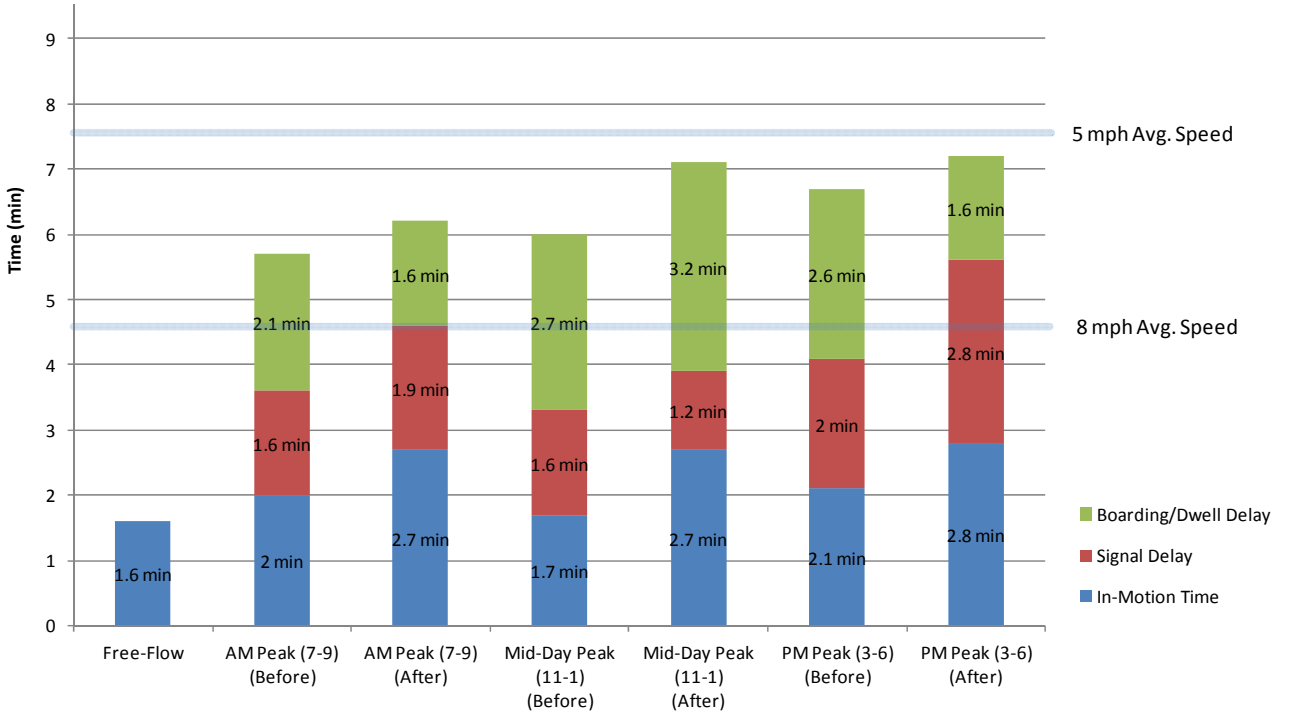


Table 25. Marquette Avenue / 2nd Avenue Bus Travel Time Comparison

Northbound 2nd Avenue



Southbound Marquette Avenue

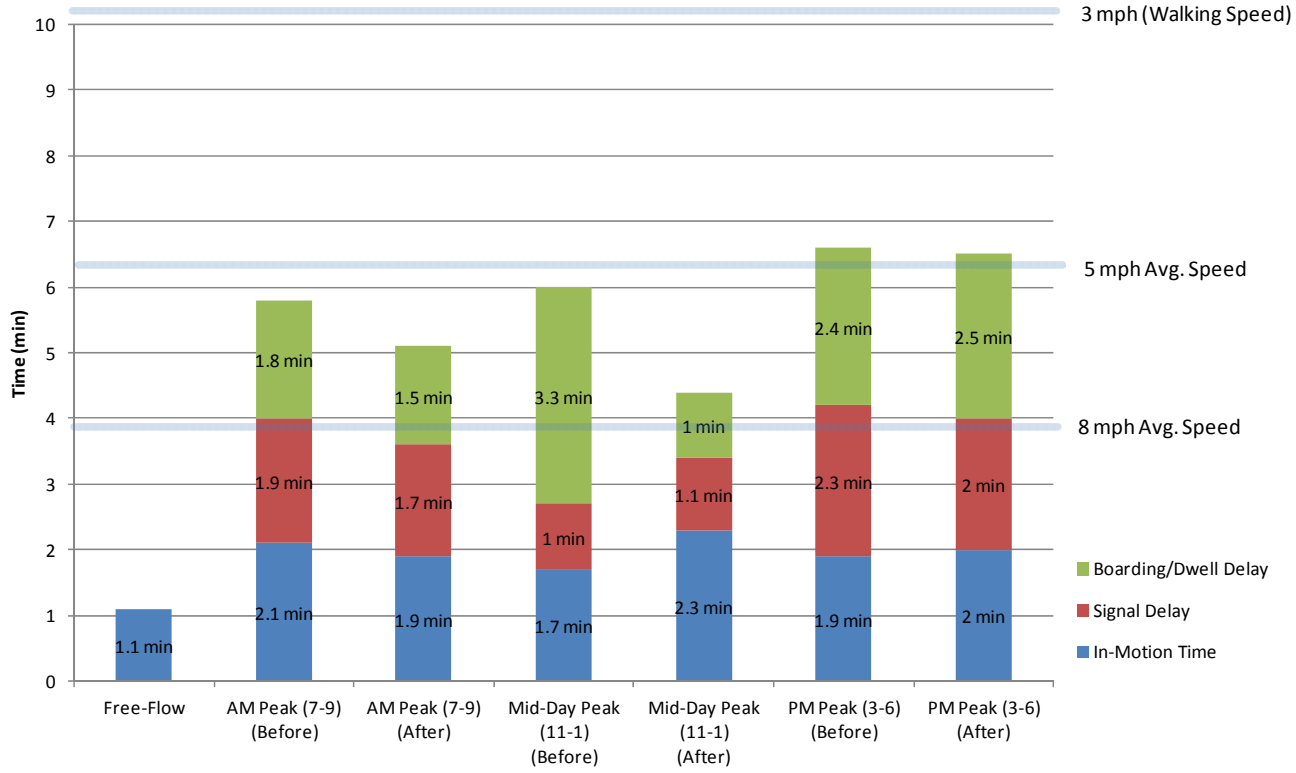


Table 26. 3rd Street Bus Travel Time Comparison

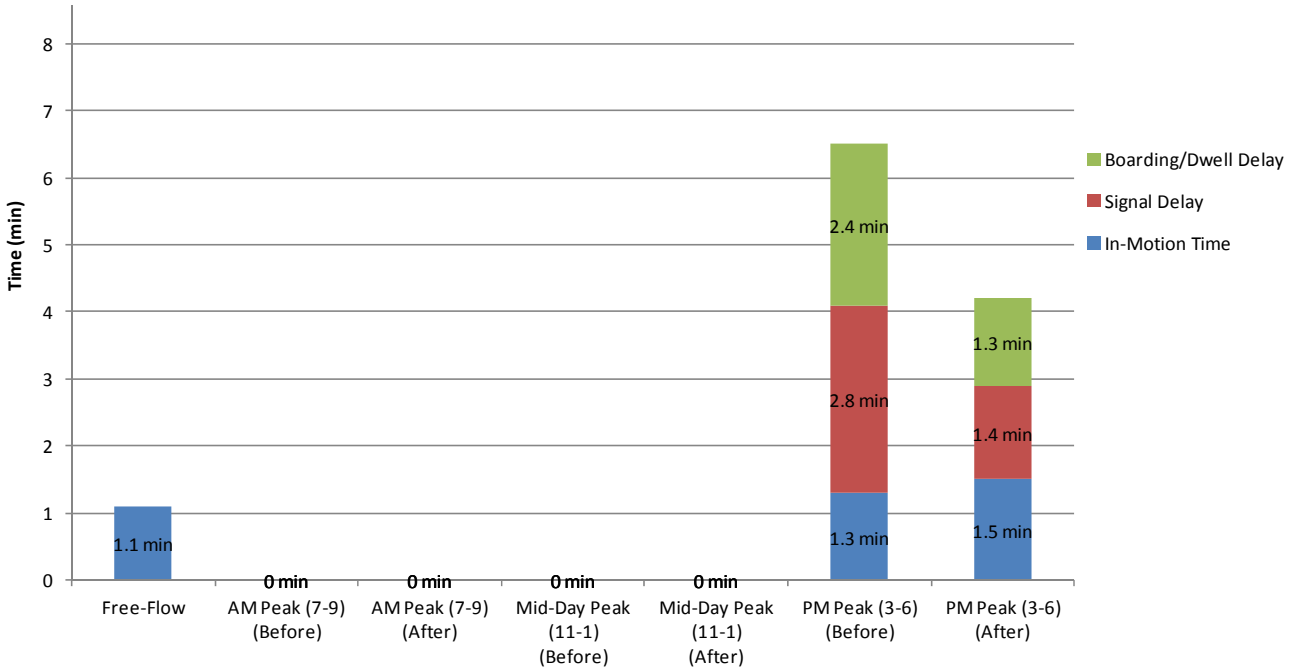
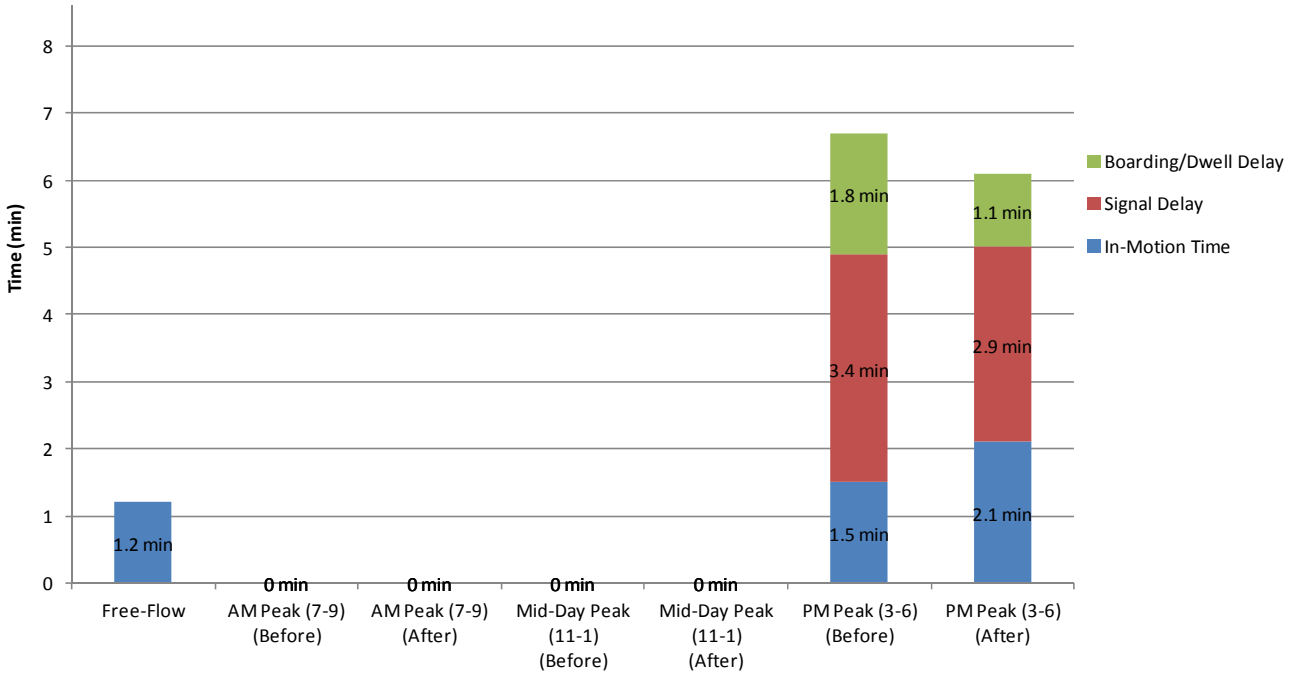


Table 27. 11th Street Bus Travel Time Comparison



4.4 Total Network Performance

Typical network performance measures of effectiveness (MOE) used in estimating the benefit of signal optimization projects include approach vehicle delay, vehicle stops, fuel consumption and air quality emissions (CO, NOx and VOC). The daily savings for each MOE throughout Downtown Minneapolis was determined by multiplying the number of hours each optimized timing plan is in effect and comparing against the corresponding existing timing plan and varying daily traffic volume conditions. It should also be noted, the overall net benefit of these measures also accounts for any impacts that occur from reprioritizing or balancing the network optimization. Output used in determining each MOE was computed using Synchro and SimTraffic. VISSIM output was used for the 5th Street LRT and the Marquette Avenue/2nd Avenue transit corridors. LRT vehicle delay was converted into transit passenger delay (person-hour delay) by using station to station ridership data provided by Metro Transit (LRT Blue Line). Passenger delay estimated for the remaining transit corridors within downtown are tabulated in the Passenger Delay column on Table 28 and assume a constant 30 passenger per bus. Table 28 provides a detailed summary of the daily MOE's and documents the net reduction in vehicle delay, vehicle stops, fuel consumption and emissions. Table 29 illustrates the overall daily and annual "before" and "after" network performance comparison and percent improvement for Downtown Minneapolis. A positive value shown in Table 28 and Table 29 is a benefit (i.e., reduction) and a negative value shown is an impact (i.e., increase).

Table 28. Measures of Effectiveness – Net Average Daily MOE Reductions

		MOE - Net Reduction from Existing to Proposed Condition[1]							
	Aggregate Timing Plans[2]	Stops (no. of veh) (All Approaches)	Delay (veh-hr) (North/South Streets)	Delay (veh-hr) (East/West Streets)	Passenger Delay (hr)[3]	Fuel Consumption (gal) (All Approaches)	Emissions CO (kg) (All Approaches)	Emissions NOx (kg) (All Approaches)	Emissions VOC (kg) (All Approaches)
Minneapolis - Downtown Signals	AM Peak Period (715 AM to 845 AM)	66,146	129.6	295.6	94.4	433	44.9	7.8	6.6
	Off Peak Periods (Remaining Daily Hours)	260,542	433.7	767.6	622.5	1767	143.7	26.0	27.1
	PM Peak Period (400 PM to 545 PM)	77,494	300.2	525.5	253.8	531	52.9	7.8	6.5
	LRT Passenger Delay (Daily)	N/A	N/A	N/A	145.4	N/A	N/A	N/A	N/A
	Marquette/2nd Ave Passenger Delay (AM/PM Peak Hour)	N/A	N/A	N/A	135.7	N/A	N/A	N/A	N/A
	Weekend Daily	205,926	291.6	584.9	38.8	1590	101.9	20.0	24.4
	Subtotal Downtown Signals	**610,107**	**1155**	**2174**	**1291**	**4321**	**343.4**	**61.6**	**64.6**

[1] A positive value equals the net reduction (i.e., benefit) and a negative value equals a net increase (i.e., impact)
[2] Off peak period includes the AM OFF, MID PEAK, MID LOW, PM OFF 1, and PM OFF 2 Plans.
[3] Passenger delay for LRT and Marquette/2nd Ave calculated using VISSIM for AM and PM peak periods.

Table 29. Measures of Effectiveness – Network Performance Comparison

MOE	Weekday (Daily)				Weekend (Daily)				Annual Reduction
	Before	After	Net Reduction	Percent Improvement	Before	After	Net Reduction	Percent Improvement	
Stops (no. of veh)	2,153,387	1,749,207	**404,181**	**18.8%**	1,298,460	1,092,534	**205,926**	**15.9%**	**122,865,610**
Delay (hr)	17,663	15,211	**2,452**	**13.9%**	8,588	7,711	**876**	**10.2%**	**706,656**
Fuel Consumption (gal)	34,543	31,812	**2,731**	**7.9%**	23,085	21,495	**1,590**	**6.9%**	**850,860**
Emission (CO) (kg)	3,551	3,310	**241**	**6.8%**	1,625	1,523	**102**	**6.3%**	**71,205**
Emission (NOx) (kg)	605	563	**42**	**6.9%**	314	295	**20**	**6.3%**	**12,520**
Emission (VOC) (kg)	529	488	**40**	**7.6%**	376	352	**24**	**6.5%**	**12,626**

4.5 Benefit/Cost Analysis

A cost benefit analysis was completed to establish the annual economic savings incurred as a result of the Downtown Retiming Project. The detailed benefit cost analysis is provided in Appendix C.

4.5.1 Project Benefit Economic Values

The project benefit MOE's are measured through the reduction in total intersection delay-hour, reduction in vehicle stops, reduction in fuel consumption and reduction of air quality emissions. Table 30 provides a summary of unit dollar values for each measure of effectiveness.

To determine the annual economic benefit of the Downtown Retiming Project, the daily estimated reductions (or increases) in MOE's are calculated and are then applied to the unit benefit.

4.5.2 Annual Economic Benefit

The net annual economic benefit is based upon 251 Monday to Fridays and 104 weekend days (10 holiday days were excluded due to atypical transit and vehicle volumes). Applying the number of days and the unit savings to each computed daily MOE, the annual net benefit (or economic savings) can be estimated. Table 31 documents the overall annual net benefit estimated as a result of the Downtown Retiming Project. Based on the results, the total estimated annual benefit is estimated at approximately 25.9 million dollars.

Table 30. Unit Economic Values

Motorist User Costs

MOE	Unit Price
Value of Time - Truck[1]	$27.20
Value of Time - Auto[1]	$15.00
Vehicle Stop[2]	$0.032
Fuel Cost[3]	$3.51

[1] Mn/DOT Office of Investment Management Benefit-Cost Analysis for Transportation Projects, Appendix A, Table A.1, SFY2014 Recommended Standard Values

[2] Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA, Table 2.3 (Vehicle Cost per Stop), September 1998 (Refer to Appendix D for calculations)

[3] US Department of Engergy, Engergy Information Administration, Average Fuel Prices 12/01/12 to 11/30/13

Air Pollutant Damage Costs and Adjustment Factors Used in HERS

Pollutant	Damage Costs ($/ton)	Urban Adjustment Factor
Carbon Monoxide (CO)	100	1
Volatile Organic Compounds (VOC)	2750	1.5
Nitrogen Oxides (NOx)	3625	1.5

HERS-ST 2.0 (Highway Economic Requirements System – State Version) Technical Reports, U.S. Department of Transportation/Federal Highway Administration, 2002.
Table E5 - "Air Pollution Damage Costs and Adjustment Factors Used in HERS."
Costs converted from Year 2000 to Year 2009 by Consumer Price Index of 1.25.

Table 31. Annual Net Benefit (dollar)

	Aggregate Timing Plans[3]	Truck Percent (N/S)	Truck Percent (E/W)	Occ.[1]	Days/ Year[2]	Value of Time Benefit ($) (North/South Streets)	Value of Time Impact ($) (East/West Streets)	Value of Time Impact ($) (Passengers)	Stops Reduction Benefit ($)	Fuel Reduction Benefit ($)	Emission Reduction Benefit ($)	Total Benefit ($)
Minneapolis - Downtown Signals	AM Peak Period (715 AM to 845 AM)	8.0%	6.7%	1.30	251	$654,544	$1,485,255	$355,571	$535,519	$381,389	$18,631	$3,430,910
	Off Peak Periods (Remaining Daily Hours)	7.0%	6.4%	1.30	251	$2,181,729	$3,851,908	$2,343,830	$2,109,362	$1,556,635	$67,126	$12,110,590
	PM Peak Period (400 PM to 545 PM)	6.7%	5.1%	1.30	251	$1,508,429	$2,623,526	$955,682	$627,393	$468,081	$18,686	$6,201,795
	LRT Passenger Delay	0.0%	0.0%	(4)	251	N/A	N/A	$547,559	N/A	N/A	N/A	$547,559
	Marquette/2nd Ave Passenger Delay	7.2%	6.0%	(5)	251	N/A	N/A	$545,411	N/A	N/A	N/A	$545,411
	Weekday Daily	7.2%	6.0%	1.30	251	$4,344,702	$7,960,689	$4,748,054	$3,272,274	$2,406,104	$104,443	$22,836,266
	Weekend Daily	1.0%	1.0%	1.30	104	$593,641	$1,190,811	$60,552	$690,788	$580,414	$22,837	$3,139,044
	Subtotal (Annual Total Benefit)					**$4,938,343**	**$9,151,500**	**$4,808,606**	**$3,963,062**	**$2,986,518**	**$127,281**	**$25,975,310**
	Total Project - Minneapolis CBD (Average Annual Benefit)					**$4,938,343**	**$9,151,500**	**$4,808,606**	**$3,963,062**	**$2,986,518**	**$127,281**	**$25,975,310**

[1] 2010 Metropolitan Council Travel Behavior Inventory (TBI) Home Interview Survey

[2] Total weekday days were reduced by 10 to account for Holidays.

[3] Off peak period includes the AM OFF, MID PEAK, MID LOW, PM OFF 1, and PM OFF 2 Plans.

[4] Based on LRT station to station ridership data provided by Metro Transit in 2011

[5] Assumes a constant average bus occupancy of 30 passengers.

4.5.3 Project Cost

Costs for most roadway improvement projects are associated with capital costs, future costs, and operations and maintenance costs. At the end of the analysis period, there

would also be a remaining capital value. For signal optimization projects, there is not a capital or future cost. The only cost is an "operations" cost and includes the labor required to develop and implement the new signal timing plans. The project funding was **$525,000** and includes all data collection and consulting fees. The project was completed for $475, 000, well under budget; however, the project cost is still assumed to be $525,000 to account for Minneapolis agency staff time involvement throughout the project process.

4.5.4 Project Benefit/Cost Ratio

The benefit/cost ratio is computed based on the comparison between the annual net benefit and the total project cost. Table 32 documents the estimated benefit/cost ratio for the total project.

Table 32. Project Benefit to Cost Ratio

Segment	Number of Intersections	Cost ($)	Benefit ($)	Benefit-Cost Ratio
Minneapolis Downtown CBD - Annual	205	$525,000	$25,975,310	**49**

As shown, the Downtown Retiming Project resulted in a benefit/cost ratio of approximately **49:1,** considering only one year of benefit. The three year benefit/cost ratio, assuming $1,000 per year per intersection for timing plan maintenance is estimated to be approximately **68:1**.

4.6 Key Project Conclusions

The following summarizes the expected project benefits with respect to the project goals:

Goal 1: Improve crosswalk crossing times for pedestrians and update timing parameters.

- A complete review of each local controller timing database was completed. New pedestrian clearance intervals, yellow change, all red clearance and minimum green intervals were implemented and are in accordance with the latest edition of the MMUTCD.
- Pedestrian crossing intervals were increased by an average 17 percent throughout the CBD.
- Other database reviews and updates included: intersection preemption parameters (where in operation), overlap clearance values, special sequence, access data and intersection startup values.

Goal 2: Improve bus transit operations and reduce route travel times to the extent feasible.

- The bus field studies found that the majority of bus corridor routes experienced a reduction in travel time. In total 32 routes were measured across the a.m., mid-day and p.m. peak periods, 22 of the routes were improved.
- The detailed VISSIM modeling completed for Marquette Avenue/2nd Avenue corridors found an estimated 6 percent and 2 percent reduction in signal delay during the a.m. and p.m. peak periods, respectively. As a result, an estimated reduction of 135 hours of passenger delay is expected.

Goal 3: Improve light rail transit operations through reducing signal delay and progressing trains between stations without stops.

- During the a.m. and p.m. peak periods, an LRT vehicle leaving a station at the start of bar signal can progress station to station in both directions between the Warehouse District and Downtown East stations. The outbound (southbound) train can progress station to station from Target Field to Downtown East during all timing plans.
- The VISSIM modeling completed for the LRT route found an expected 33 percent, 8 percent and 52 percent reduction in signal delay for the outbound (southbound) LRV during the a.m., mid-day and p.m. peak periods, respectively. A 26 percent, 15 percent and 18 percent reduction in signal delay was found for the inbound (northbound) LRV during the a.m., mid-day and p.m. peak periods, respectively. In total, the reduction in signal delay is expected to result in a reduction of 145 hours of passenger delay.
- The field data collected on board the LRV found a 5 percent reduction in overall travel time for the inbound (northbound) train throughout the day (approximately 30 seconds). The outbound (southbound) train was found to experience an 11 to 17 percent reduction in travel time (1 to 2 minutes) over the day.

Goal 4: Improve the overall intersection traffic signal efficiency by improving traffic flow progression and reducing delays, fuel consumption and emission output for motor vehicle movements.

- On a daily basis, the overall network performance found a 14 percent reduction in total vehicle delay, 8 percent reduction in fuel consumption, 7 percent reduction in emission output and a 19 percent reduction in total vehicle stops.
- The field travel time studies found that 60 percent of the blocks experienced a reduction in travel time (70 percent of all blocks were either unchanged or experienced a reduction in travel time).
- The travel time studies found an overall average reduction of 14 percent. On a route by route basis during the a.m., mid-day, p.m. peak periods the majority of routes experienced a reduction in travel time (46 of the 60 routes collected),

with a few routes experiencing significant savings (i.e., eastbound Washington Avenue travel time reduced by 50 percent).

The optimized and implemented timing plans have met the project goals and have resulted in an overall traffic flow improvement throughout Downtown for motorists and transit as validated through both traffic modeling and field data validation. Considering the overall Downtown network, the benefit analysis estimates the Downtown Retiming Project is expected to result in a one year 49:1 benefit to cost ratio, a three year 68:1 benefit to cost ratio, and an estimated annual economic savings of 25.9 million dollars. The project benefit includes an estimated 17 percent increase in pedestrian crossing time and estimated annual savings of 706,000 hours of delay, 850,000 gallons of gasoline and 71,000 kilograms of CO emissions.

Appendix A:
Existing Conditions LOS Analysis

Existing Conditions Intersection Delay and LOS

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
10	8th Street S at 9th Avenue S	7.0	-	-	-	7.0	A	6.0	-	-	-	5.0	A	9.0	-	12.0	-	9.0	A
18	LaSalle Avenue S at Mid-Block	-	23.0	3.0	3.0	4.0	A	-	23.0	4.0	5.0	8.0	A	-	38.0	8.0	20.0	22.0	C
22	9th Street S at Chicago Avenue S	-	23.0	10.0	16.0	14.0	B	-	19.0	15.0	19.0	18.0	B	-	43.0	12.0	48.0	35.0	C
27	Chicago Avenue S at 17th Street E	-	51.0	6.0	2.0	21.0	C	-	25.0	7.0	7.0	12.0	B	-	44.0	6.0	7.0	16.0	B
30	Park Avenue S at 15th Street E	28.0	12.0	9.0	-	11.0	B	21.0	7.0	7.0	-	9.0	A	24.0	13.0	12.0	-	13.0	B
36	Portland Avenue S at 15th Street E	15.0	30.0	-	11.0	15.0	B	3.0	28.0	-	6.0	9.0	A	51.0	54.0	-	7.0	20.0	B
53	Lyndale Avenue N SB at Dunwoody Boulevard W	15.0	21.0	-	**69.0**	43.0	D	13.0	11.0	-	28.0	18.0	B	12.0	22.0	-	**57.0**	35.0	C
67	Washington Avenue S at 4th Avenue S	22.0	17.0	-	-	19.3	B	19.8	21.3	-	-	20.5	C	29.3	15.2	-	-	21.3	C
77	Cedar Avenue S at 6th Street S	12.0	19.0	8.0	5.0	8.0	A	8.0	10.0	11.0	12.0	11.0	B	23.0	16.0	9.0	9.0	12.0	B
84	Washington Avenue S at 13th Avenue S	21.3	12.9	-	24.0	20.9	C	11.3	41.1	-	29.8	22.9	C	33.5	**90.4**	-	**100.0**	**61.4**	**E**
85	Washington Avenue S at Park Avenue S	10.9	10.0	16.7	28.9	12.0	B	12.7	10.5	20.3	21.6	13.6	B	**66.6**	16.4	38.7	40.8	41.6	D
87	Washington Avenue S at 14th Avenue S	10.9	6.8	22.4	-	13.5	B	17.6	17.0	20.4	-	17.9	B	29.6	**58.6**	43.2	-	40.2	D
99	10th Street N at Currie Avenue W	1.0	-	18.0	38.0	1.0	A	1.0	-	9.0	30.0	6.0	A	16.0	-	2.0	36.0	21.0	C
103	3rd Street S at Chicago Avenue S	-	14.0	18.0	11.0	14.0	B	-	12.0	12.0	9.0	11.0	B	-	14.0	9.0	10.0	12.0	B
107	Dunwoody Boulevard W at Colfax Avenue S	24.0	11.0	55.0	15.0	23.0	C	14.0	9.0	17.0	23.0	14.0	B	15.0	4.0	33.0	28.0	13.0	B
110	Washington Avenue S at Chicago Avenue S	16.7	13.3	17.7	26.7	15.3	B	12.1	14.0	20.9	23.6	14.2	B	54.1	31.0	35.2	36.3	42.0	D
111	Washington Avenue S at 10th Avenue S	8.1	7.4	25.7	28.5	8.5	A	19.5	20.2	22.7	18.6	19.9	B	**117.9**	18.2	43.1	48.4	**69.6**	**E**
169	Chicago Avenue S at 14th Street E	26.0	24.0	4.0	12.0	14.0	B	26.0	22.0	5.0	1.0	13.0	B	17.0	31.0	6.0	3.0	12.0	B
200	6th Street S at 11th Avenue S	12.0	-	4.0	29.0	20.0	B	5.0	-	7.0	10.0	7.0	A	7.0	-	14.0	9.0	9.0	A
202	Cedar Avenue S at Riverside Avenue S	29.0	19.0	11.0	18.0	17.0	B	21.0	9.0	14.0	19.0	15.0	B	27.0	16.0	27.0	21.0	22.0	C
220	Cedar Avenue S at 5th Street	-	-	3.0	5.0	4.0	A	-	-	3.0	4.0	3.0	A	-	-	4.0	4.0	4.0	A
222	Washington Avenue S at Cedar Avenue S	24.0	19.0	13.0	12.0	21.0	C	20.0	33.0	12.0	15.0	22.0	C	**89.0**	46.0	18.0	24.0	**60.0**	**E**
223	15th Avenue S at Holiday Inn	1.0	3.0	-	18.0	2.0	A	1.0	5.0	-	16.0	4.0	A	1.0	7.0	-	15.0	5.0	A
234	Washington Avenue S at 11th Avenue S	22.6	**62.6**	26.9	27.7	41.3	D	36.3	22.5	18.9	24.3	27.7	C	**83.4**	**93.9**	30.8	**62.7**	**71.9**	**E**
239	7th Street N at 3rd Avenue N	-	1.0	-	-	1.0	A	-	3.0	-	-	3.0	A	-	5.0	-	-	5.0	A
240	10th Street N at 3rd Avenue N	6.0	-	-	41.0	10.0	A	4.0	-	-	20.0	7.0	A	5.0	-	-	41.0	16.0	B
241	10th Street N at Glenwood Avenue N	18.0	10.0	-	16.0	16.0	B	11.0	8.0	-	15.0	13.0	B	34.0	11.0	-	16.0	21.0	C
245	Lyndale Avenue S at Vineland Place/Oak Grove Street	**64.0**	**78.0**	27.6	29.7	33.0	C	35.0	**69.0**	12.9	24.0	23.5	C	**109.0**	**233.0**	19.8	42.4	41.8	D
252	Lyndale Avenue S at Groveland Avenue/Hennepin Avenue	**83.0**	55.0	31.1	14.1	27.7	C	**62.0**	43.0	21.4	17.0	21.8	C	**75.0**	**59.0**	26.0	23.8	29.5	C
253	Lyndale Avenue S at Ramp D	42.5	44.3	34.8	-	40.0	D	35.5	35.4	29.8	-	33.3	C	31.3	38.5	37.3	-	35.8	D
258	5th Street N at 3rd Avenue N	14.0	20.0	-	28.0	20.0	B	11.0	10.0	-	34.0	21.0	C	17.0	18.0	-	30.0	22.0	C
289	3rd Avenue S at 16th Street E	14.0	26.0	22.0	17.0	19.0	B	10.0	21.0	8.0	11.0	11.0	B	12.0	21.0	**72.0**	19.0	36.0	D
304	Park Avenue S at 16th Street E	13.0	25.0	11.0	-	12.0	B	7.0	17.0	10.0	-	10.0	A	24.0	25.0	10.0	-	11.0	B
325	5th Street S at 11th Avenue S	-	17.0	32.0	**152.0**	46.0	D	20.0	12.0	31.0	24.0	20.0	B	40.0	25.0	26.0	23.0	26.0	C
357	7th Street S at 11th Avenue S	-	41.0	10.0	6.0	22.0	C	-	18.0	7.0	7.0	11.0	B	-	33.0	13.0	1.0	17.0	B
366	5th Street N at 5th Avenue N	5.0	3.0	-	27.0	6.0	A	4.0	4.0	-	28.0	9.0	A	9.0	8.0	-	28.0	12.0	B
392	11th Avenue S at 14th Street E	7.0	-	18.0	10.0	14.0	B	7.0	-	16.0	11.0	12.0	B	16.0	-	15.0	8.0	13.0	B
393	8th Street S at 11th Avenue S	7.0	-	6.0	16.0	9.0	A	1.0	-	9.0	8.0	6.0	A	6.0	-	13.0	15.0	9.0	A
418	3rd Avenue S at 14th Street E	-	22.0	21.0	1.0	10.0	A	-	16.0	17.0	2.0	8.0	A	-	20.0	28.0	1.0	8.0	A
422	16th Street E at 4th Avenue S	1.0	2.0	-	-	1.0	A	1.0	1.0	-	-	1.0	A	2.0	2.0	-	-	2.0	A
423	15th Street E at 4th Avenue S	-	19.0	22.0	18.0	19.0	B	8.0	23.0	12.0	15.0	19.0	B	11.0	**107.0**	23.0	22.0	**63.0**	**E**
434	Cedar Avenue S at 3rd Street	30.0	-	7.0	9.0	10.0	A	19.0	-	25.0	10.0	17.0	B	37.0	-	16.0	35.0	28.0	C
443	Washington Avenue N at 2nd Avenue N	25.0	20.4	29.1	15.8	24.4	C	9.1	8.0	24.1	18.0	11.8	B	34.4	22.5	21.7	**77.7**	29.5	C
546	2nd Street N at 3rd Avenue N	14.0	14.0	14.0	21.0	16.0	B	13.0	15.0	10.0	14.0	13.0	B	20.0	30.0	10.0	17.0	19.0	B
570	6th Street S at Mid-Block	14.0	-	-	40.0	14.0	B	11.0	-	-	31.0	11.0	B	9.0	-	-	40.0	10.0	A
579	7th Street S at Chicago Avenue S	-	18.0	23.0	20.0	19.0	B	-	8.0	8.0	10.0	8.0	A	-	10.0	19.0	9.0	12.0	B
607	2nd Avenue S at Convention Center West	2.0	5.0	-	-	4.0	A	7.0	3.0	-	-	4.0	A	5.0	6.0	-	-	5.0	A
608	2nd Avenue S at Convention Center East	2.0	2.0	-	-	2.0	A	4.0	8.0	-	-	7.0	A	4.0	10.0	-	-	9.0	A
609	7th Street S at Mid-Block	-	1.0	-	-	1.0	A	-	11.0	-	-	11.0	B	-	1.0	-	-	1.0	A
610	12th Street N at Glenwood Avenue N	26.0	21.0	10.0	6.0	19.0	B	9.0	11.0	13.0	8.0	11.0	B	22.0	13.0	17.0	6.0	16.0	B
612	1st Street S at 2nd Avenue S	42.0	12.0	18.0	-	28.0	C	30.0	5.0	9.0	-	16.0	B	34.0	13.0	25.0	-	25.0	C
613	9th Street N at Glenwood Avenue N	13.0	37.0	15.0	-	31.0	C	18.0	19.0	1.0	-	6.0	A	24.0	31.0	4.0	-	15.0	B
614	7th Street N at 2nd Avenue N	25.0	13.0	32.0	14.0	22.0	C	17.0	37.0	31.0	21.0	32.0	C	18.0	**68.0**	54.0	28.0	48.0	D
616	5th Street N at 2nd Avenue N	**87.0**	18.0	44.0	43.0	47.0	D	44.0	17.0	48.0	47.0	40.0	D	**69.0**	25.0	46.0	49.0	47.0	D
617	4th Street N at 2nd Avenue N	52.0	-	36.0	55.0	50.0	D	22.0	-	19.0	32.0	24.0	C	24.0	-	26.0	42.0	28.0	C
618	3rd Street N at 2nd Avenue N	-	6.0	18.0	-	10.0	A	-	4.0	10.0	-	6.0	A	-	16.0	28.0	-	19.0	B
622	12th Street N at Currie Avenue W	1.0	2.0	26.0	-	2.0	A	1.0	2.0	21.0	-	3.0	A	4.0	1.0	30.0	-	3.0	A
625	1st Avenue N at 8th Street N & 9th Street N	17.2	-	10.9	15.7	13.4	B	11.7	-	16.4	12.0	13.8	B	20.0	-	44.3	17.4	30.0	C
626	7th Street N at 1st Avenue N	-	10.1	16.9	3.7	7.9	A	-	8.5	7.0	5.6	7.4	A	-	8.3	14.7	12.7	10.6	B
627	6th Street N at 1st Avenue N	54.3	-	14.6	26.7	38.8	D	14.8	-	8.3	14.9	13.6	B	22.6	-	9.6	16.1	16.1	B
628	5th Street N at 1st Avenue N	-	21.0	32.1	43.3	39.6	D	-	19.1	25.3	31.3	28.1	C	-	22.8	30.4	29.3	28.7	C
629	4th Street N at 1st Avenue N	8.1	-	11.7	36.9	12.3	B	9.8	-	11.6	12.7	10.8	B	12.7	-	20.9	11.0	13.6	B
630	3rd Street N at 1st Avenue N	-	5.0	16.3	10.2	8.0	A	-	16.9	8.1	10.6	14.2	B	-	8.4	51.4	32.2	17.9	B
631	Washington Avenue N at 1st Avenue N	24.0	14.9	16.4	18.8	20.2	C	12.5	16.4	18.2	19.4	15.0	B	37.0	20.1	13.0	23.2	26.8	C
633	1st Avenue N at 2nd Street N	9.4	7.6	23.4	17.6	11.3	B	9.7	5.6	24.2	16.1	11.8	B	29.4	17.9	12.3	19.9	21.4	C
635	12th Street N at Hawthorne Avenue W	31.1	-	**87.1**	6.5	**64.3**	**E**	21.8	-	6.1	5.2	7.3	A	28.3	-	7.8	9.3	11.8	B
637	10th Street N at Hawthorne Avenue W	14.0	-	19.1	51.1	22.2	C	14.0	-	7.8	8.8	10.3	B	36.2	-	5.2	17.5	24.1	C
638	9th Street N at Hawthorne Avenue W	-	12.4	15.1	6.4	12.0	B	-	14.8	14.6	3.0	11.1	B	-	18.2	47.0	22.1	24.3	C
641	Hennepin Avenue S at Dunwoody Boulevard W	34.0	14.2	20.3	17.7	22.3	C	15.4	35.6	7.6	20.5	14.1	B	14.8	25.5	8.1	14.9	13.4	B
642	Hennepin Avenue S at Maple & 16th Street N	16.3	20.8	4.1	13.4	6.9	A	17.7	18.9	7.1	26.9	15.8	B	18.8	26.1	13.2	20.3	17.3	B
644	Hennepin Avenue S at Spruce Place	20.4	19.8	17.0	6.7	15.2	B	11.7	11.0	11.9	30.6	19.5	B	18.9	24.0	20.4	17.6	19.7	B
645	Hennepin Avenue S at 13th Street N	**80.3**	27.4	14.7	6.2	15.2	B	16.2	16.1	5.4	6.3	7.0	A	19.0	26.0	6.5	7.7	9.1	A
646	Hennepin Avenue S at 12th Street N	19.9	-	**55.7**	32.1	34.9	C	13.3	-	6.5	19.3	13.0	B	17.1	-	31.9	23.6	23.9	C
647	Hennepin Avenue S at 11th Street N	-	54.0	38.4	8.4	39.4	D	-	8.0	6.0	14.8	9.3	A	-	29.0	11.2	34.2	25.8	C
648	Hennepin Avenue S at 10th Street N	20.3	-	**104.3**	13.4	45.3	D	6.6	-	8.8	26.3	13.2	B	13.0	-	46.6	30.2	28.6	C
649	Hennepin Avenue S at 9th Street N	-	12.6	17.5	24.9	17.5	B	-	12.6	6.4	11.3	10.3	B	-	26.4	15.5	34.4	24.8	C
650	Hennepin Avenue S at 8th Street N	24.9	-	20.6	11.3	19.5	B	15.4	-	21.9	12.8	17.4	B	26.2	-	14.8	10.0	15.3	B
651	Hennepin Avenue S at 7th Street N	-	7.1	6.0	26.1	11.4	B	-	32.6	5.0	11.7	20.0	B	-	27.9	24.7	24.6	26.2	C
652	Hennepin Avenue S at 6th Street N	50.2	-	27.1	27.9	37.4	D	17.7	-	29.9	7.6	20.0	B	31.8	-	54.9	13.7	36.0	D
653	Hennepin Avenue S at 5th Street N/5th Street S	-	45.1	20.8	31.8	28.6	C	-	34.5	28.8	18.1	25.3	C	-	25.0	**96.3**	24.1	**58.3**	**E**
654	Hennepin Avenue S at 4th Street N	12.6	3.2	**59.7**	36.9	27.1	C	18.1	4.6	37.2	14.0	22.6	C	21.0	8.7	**118.5**	35.8	**56.3**	**E**
655	Hennepin Avenue S at 3rd Street N	-	12.8	13.1	25.2	17.0	B	-	3.7	14.2	21.8	11.9	B	-	7.9	27.8	37.5	18.1	B
656	Hennepin Avenue S at Washington Avenue N	25.7	37.7	42.2	41.1	35.0	C	23.6	43.2	33.8	31.9	32.6	C	34.6	46.5	35.2	32.3	37.8	D
657	Hennepin Avenue S at 2nd Street N	15.1	-	22.0	14.4	17.5	B	11.1	-	14.7	7.2	11.3	B	50.0	-	21.5	10.1	22.2	C
658	Hennepin Avenue S at 1st Street N	25.6	14.9	21.0	24.4	22.6	C	25.8	12.3	17.9	18.3	18.4	B	46.7	20.6	25.2	28.8	29.5	C

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
664	12th Street S at 3rd Avenue S	27.0	-	8.0	12.0	20.0	B	14.0	-	22.0	13.0	15.0	B	10.0	-	6.0	13.0	11.0	B
666	12th Street S at Harmon Place S	12.0	-	15.0	19.0	13.0	B	8.0	-	8.0	13.0	8.0	A	17.0	-	8.0	24.0	18.0	B
667	11th Street S at Harmon Place S	-	6.0	23.0	9.0	9.0	A	-	9.0	14.0	3.0	9.0	A	-	10.0	26.0	17.0	12.0	B
668	10th Street S at Harmon Place S	17.0	-	13.0	-	17.0	B	10.0	-	1.0	-	9.0	A	10.0	-	1.0	-	9.0	A
675	Grant Street W at LaSalle Avenue S	23.0	8.0	-	9.0	13.0	B	12.0	8.0	-	6.0	8.0	A	30.0	33.0	-	15.0	23.0	C
676	19th Avenue S at 2nd Street S	25.0	36.0	6.0	8.0	11.0	B	20.0	26.0	1.0	4.0	5.0	A	25.0	38.0	4.0	6.0	9.0	A
677	12th Street S at LaSalle Avenue S	13.0	-	12.0	13.0	13.0	B	4.0	-	10.0	10.0	7.0	A	12.0	-	13.0	8.0	11.0	B
678	11th Street S at LaSalle Avenue S	-	12.0	10.0	13.0	12.0	B	-	34.0	4.0	11.0	23.0	C	-	31.0	21.0	38.0	32.0	C
679	10th Street S at LaSalle Avenue S	**82.0**	-	35.0	8.0	**63.0**	**E**	7.0	-	15.0	6.0	8.0	A	17.0	-	19.0	8.0	14.0	B
680	9th Street S at LaSalle Avenue S	-	1.0	16.0	9.0	6.0	A	-	1.0	8.0	5.0	3.0	A	-	8.0	21.0	15.0	11.0	B
681	8th Street S at LaSalle Avenue S	12.0	-	54.0	25.0	20.0	B	24.0	-	36.0	16.0	27.0	C	17.0	-	**99.0**	32.0	47.0	D
682	Nicollet Avenue S at Grant Street W	30.0	24.0	8.0	10.0	20.0	B	11.0	7.0	14.0	14.0	11.0	B	14.0	7.0	18.0	15.0	12.0	B
683	13th Street S at Nicollet Mall	-	24.0	4.0	20.0	11.0	B	-	8.0	7.0	4.0	7.0	A	-	17.0	13.0	14.0	13.0	B
684	12th Street S at Nicollet Mall	17.0	-	8.0	31.0	17.0	B	11.0	-	9.0	11.0	11.0	B	24.0	-	3.0	-	20.0	B
685	11th Street S at Nicollet Mall	-	35.0	2.0	1.0	31.0	C	-	25.0	5.0	25.0	24.0	C	-	21.0	36.0	29.0	22.0	C
686	10th Street S at Nicollet Mall	5.0	-	16.0	33.0	7.0	A	7.0	-	1.0	13.0	7.0	A	23.0	-	2.0	21.0	21.0	C
687	9th Street S at Nicollet Mall	-	5.0	2.0	33.0	6.0	A	-	9.0	1.0	7.0	9.0	A	-	7.0	15.0	32.0	8.0	A
688	8th Street S at Nicollet Mall	43.0	-	2.0	4.0	39.0	D	20.0	-	4.0	24.0	19.0	B	12.0	-	2.0	4.0	10.0	A
689	7th Street S at Nicollet Mall	-	21.0	26.0	27.0	21.0	C	-	8.0	24.0	35.0	11.0	B	-	23.0	34.0	41.0	24.0	C
690	6th Street S at Nicollet Mall	24.0	-	5.0	16.0	23.0	C	20.0	-	40.0	16.0	21.0	C	14.0	-	1.0	4.0	12.0	B
691	5th Street S at Nicollet Mall	-	16.0	16.0	14.0	16.0	B	-	19.0	1.0	2.0	12.0	B	-	30.0	9.0	9.0	24.0	C
692	4th Street S at Nicollet Mall	16.0	3.0	10.0	17.0	15.0	B	11.0	9.0	12.0	33.0	12.0	B	10.0	1.0	35.0	2.0	11.0	B
693	3rd Street S at Nicollet Mall	-	6.0	4.0	38.0	8.0	A	-	9.0	32.0	14.0	10.0	A	-	5.0	48.0	34.0	7.0	A
694	Washington Avenue S at Nicollet Mall	15.3	21.9	19.6	-	18.1	B	14.9	25.8	15.7	-	20.2	C	18.2	40.6	34.0	-	30.0	C
695	Grant Street E at Marquette Avenue S	10.0	13.0	20.0	18.0	16.0	B	17.0	9.0	8.0	-	10.0	A	9.0	27.0	19.0	3.0	22.0	C
696	13th Street S at Marquette Avenue S	51.0	-	2.0	1.0	9.0	A	22.0	-	1.0	7.0	5.0	A	26.0	-	3.0	3.0	8.0	A
697	12th Street S at Marquette Avenue S	12.0	-	13.0	4.0	12.0	B	16.0	-	10.0	5.0	14.0	B	19.0	-	7.0	18.0	16.0	B
698	11th Street S at Marquette Avenue S	-	27.0	14.0	38.0	23.0	C	-	15.0	8.0	3.0	12.0	B	-	**58.0**	14.0	20.0	48.0	D
699	10th Street S at Marquette Avenue S	42.0	-	29.0	25.0	36.0	D	15.0	-	25.0	9.0	19.0	B	4.0	-	30.0	16.0	13.0	B
700	9th Street S at Marquette Avenue S	-	16.0	20.0	31.0	19.0	B	-	7.0	12.0	26.0	10.0	A	-	8.0	17.0	1.0	10.0	A
701	8th Street S at Marquette Avenue S	20.0	-	45.0	5.0	31.0	C	17.0	-	16.0	25.0	17.0	B	38.0	-	14.0	10.0	25.0	C
702	7th Street S at Marquette Avenue S	-	12.0	11.0	41.0	14.0	B	-	11.0	7.0	29.0	10.0	A	-	39.0	20.0	11.0	29.0	C
703	6th Street S at Marquette Avenue S	47.0	-	12.0	4.0	34.0	C	3.0	-	17.0	24.0	9.0	A	16.0	-	35.0	42.0	26.0	C
704	5th Street S at Marquette Avenue S	-	28.0	25.0	21.0	25.0	C	-	12.0	47.0	10.0	36.0	D	-	30.0	31.0	3.0	25.0	C
705	4th Street S at Marquette Avenue S	10.0	23.0	8.0	4.0	10.0	A	17.0	12.0	21.0	2.0	18.0	B	21.0	12.0	26.0	2.0	21.0	C
706	3rd Street S at Marquette Avenue S	-	3.0	17.0	23.0	9.0	A	-	12.0	14.0	14.0	13.0	B	-	37.0	12.0	36.0	29.0	C
707	Washington Avenue S at Marquette Avenue S	20.8	11.9	19.9	20.8	17.8	B	4.3	7.0	22.6	20.6	9.8	A	23.5	35.5	20.1	24.8	27.3	C
709	1st Street S at Marquette Avenue S	36.0	10.0	8.0	-	23.0	C	26.0	8.0	16.0	-	17.0	B	21.0	12.0	15.0	-	16.0	B
711	12th Street S at 2nd Avenue S	33.0	-	38.0	17.0	30.0	C	17.0	-	37.0	15.0	19.0	B	27.0	-	17.0	37.0	31.0	C
712	11th Street S at 2nd Avenue S	-	20.0	4.0	10.0	18.0	B	-	19.0	13.0	20.0	19.0	B	-	31.0	-	6.0	22.0	C
713	10th Street S at 2nd Avenue S	26.0	-	43.0	10.0	23.0	C	14.0	-	10.0	12.0	13.0	B	29.0	-	16.0	5.0	19.0	B
714	9th Street S at 2nd Avenue S	-	16.0	31.0	11.0	16.0	B	-	8.0	10.0	5.0	7.0	A	-	21.0	25.0	10.0	17.0	B
715	8th Street S at 2nd Avenue S	21.0	-	13.0	17.0	19.0	B	16.0	-	18.0	11.0	14.0	B	24.0	-	12.0	18.0	20.0	B
716	7th Street S at 2nd Avenue S	-	46.0	2.0	12.0	33.0	C	-	17.0	13.0	17.0	17.0	B	-	**59.0**	15.0	23.0	43.0	D
717	6th Street S at 2nd Avenue S	**61.0**	-	31.0	4.0	40.0	D	19.0	-	8.0	17.0	18.0	B	**129.0**	-	8.0	21.0	**91.0**	**F**
718	5th Street S at 2nd Avenue S	-	17.0	1.0	16.0	14.0	B	-	16.0	6.0	15.0	14.0	B	-	30.0	4.0	16.0	16.0	B
719	4th Street S at 2nd Avenue S	55.0	38.0	2.0	16.0	40.0	D	2.0	21.0	40.0	18.0	8.0	A	12.0	38.0	15.0	13.0	13.0	B
720	3rd Street S at 2nd Avenue S	-	13.0	2.0	14.0	12.0	B	-	10.0	4.0	13.0	11.0	B	-	32.0	32.0	29.0	31.0	C
721	Washington Avenue S at 2nd Avenue S	14.4	19.3	6.6	18.4	16.0	B	10.6	15.5	15.1	12.7	12.8	B	39.5	19.6	28.6	16.7	27.7	C
724	11th Street N at Hawthorne Avenue W	-	11.2	13.4	3.5	10.6	B	-	8.3	14.8	5.0	8.2	A	-	27.5	25.8	23.4	25.4	C
726	11th Street S at 3rd Avenue S	-	11.0	12.0	5.0	10.0	A	-	8.0	10.0	6.0	8.0	A	-	10.0	25.0	17.0	15.0	B
727	10th Street S at 3rd Avenue S	35.0	-	44.0	7.0	33.0	C	26.0	-	12.0	6.0	18.0	B	23.0	-	24.0	9.0	20.0	B
728	9th Street S at 3rd Avenue S	-	8.0	15.0	22.0	13.0	B	-	8.0	3.0	6.0	5.0	A	-	5.0	7.0	15.0	8.0	A
729	8th Street S at 3rd Avenue S	39.0	-	49.0	12.0	35.0	C	9.0	-	16.0	6.0	10.0	A	20.0	-	14.0	7.0	15.0	B
730	7th Street S at 3rd Avenue S	-	13.0	5.0	13.0	11.0	B	-	9.0	3.0	18.0	9.0	A	-	15.0	35.0	31.0	25.0	C
731	6th Street S at 3rd Avenue S	8.0	-	42.0	2.0	17.0	B	26.0	-	29.0	9.0	23.0	C	12.0	-	14.0	19.0	15.0	B
732	5th Street S at 3rd Avenue S	-	-	12.0	**76.0**	**56.0**	**E**	-	-	17.0	28.0	22.0	C	-	-	10.0	10.0	10.0	A
733	4th Street S at 3rd Avenue S	14.0	4.0	23.0	18.0	17.0	B	13.0	11.0	21.0	3.0	13.0	B	7.0	4.0	**97.0**	25.0	46.0	D
734	3rd Street S at 3rd Avenue S	-	18.0	22.0	25.0	22.0	C	-	6.0	7.0	18.0	10.0	A	-	9.0	9.0	40.0	15.0	B
735	Washington Avenue S at 3rd Avenue S	22.4	40.5	27.7	24.9	28.8	C	20.1	32.7	31.1	18.9	25.6	C	25.6	48.2	**71.6**	21.2	43.0	D
736	2nd Street S at 3rd Avenue S	23.0	26.0	10.0	6.0	10.0	A	16.0	21.0	12.0	19.0	17.0	B	35.0	47.0	22.0	12.0	24.0	C
737	1st Street S at 3rd Avenue S	36.0	33.0	5.0	23.0	23.0	C	22.0	17.0	16.0	23.0	20.0	B	42.0	**89.0**	16.0	47.0	39.0	D
740	11th Street S at 4th Avenue S	-	23.0	22.0	12.0	22.0	C	-	15.0	9.0	6.0	13.0	B	-	31.0	10.0	7.0	24.0	C
741	10th Street S at 4th Avenue S	7.0	-	-	6.0	7.0	A	7.0	-	-	11.0	9.0	A	12.0	-	-	14.0	13.0	B
742	9th Street S at 4th Avenue S	-	13.0	-	8.0	11.0	B	-	10.0	-	5.0	7.0	A	-	16.0	-	10.0	13.0	B
743	8th Street S at 4th Avenue S	12.0	-	-	10.0	11.0	B	9.0	-	-	1.0	6.0	A	10.0	-	-	14.0	12.0	B
744	7th Street S at 4th Avenue S	-	15.0	-	6.0	12.0	B	-	5.0	-	5.0	5.0	A	-	22.0	-	14.0	19.0	B
745	6th Street S at 4th Avenue S	12.0	-	-	14.0	13.0	B	13.0	-	-	12.0	12.0	B	6.0	-	-	7.0	6.0	A
746	5th Street S at 4th Avenue S	-	1.0	-	20.0	15.0	B	-	5.0	-	12.0	9.0	A	-	6.0	-	34.0	30.0	C
747	4th Street S at 4th Avenue S	14.0	1.0	-	6.0	11.0	B	4.0	18.0	-	7.0	6.0	A	3.0	26.0	-	12.0	8.0	A
748	3rd Street S at 4th Avenue S	-	5.0	-	22.0	11.0	B	-	7.0	-	13.0	9.0	A	-	2.0	-	14.0	6.0	A
752	10th Street S at 5th Avenue S	50.0	-	10.0	-	18.0	B	20.0	-	9.0	-	13.0	B	37.0	-	15.0	-	25.0	C
754	8th Street S at 5th Avenue S	22.0	-	4.0	-	9.0	A	5.0	-	2.0	-	4.0	A	10.0	-	3.0	-	7.0	A
755	7th Street S at 5th Avenue S	-	18.0	9.0	-	13.0	B	-	3.0	4.0	-	4.0	A	-	5.0	10.0	-	8.0	A
756	6th Street S at 5th Avenue S	4.0	-	9.0	-	6.0	A	8.0	-	4.0	-	6.0	A	8.0	-	11.0	-	9.0	A
757	5th Street S at 5th Avenue S	-	33.0	15.0	-	22.0	C	-	18.0	6.0	-	9.0	A	-	8.0	20.0	-	19.0	B
758	4th Street S at 5th Avenue S	22.0	5.0	7.0	-	13.0	B	8.0	6.0	6.0	-	7.0	A	6.0	7.0	17.0	-	13.0	B
759	3rd Street S at 5th Avenue S	-	2.0	16.0	-	10.0	A	-	3.0	3.0	-	3.0	A	-	2.0	3.0	-	3.0	A

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
760	Washington Avenue S at 5th Avenue S	17.4	31.3	9.7	20.4	21.6	C	7.1	12.8	15.2	18.8	11.5	B	46.9	28.8	16.9	41.4	29.9	C
761	Portland Avenue S at Grant Street E	11.0	9.0	-	11.0	11.0	B	7.0	14.0	-	3.0	6.0	A	25.0	28.0	-	10.0	14.0	B
762	10th Street S at Portland Avenue S	3.0	-	-	4.0	4.0	A	1.0	-	-	7.0	5.0	A	5.0	-	-	6.0	5.0	A
764	8th Street S at Portland Avenue S	2.0	-	-	6.0	5.0	A	4.0	-	-	4.0	4.0	A	17.0	-	-	8.0	12.0	B
765	7th Street S at Portland Avenue S	-	8.0	-	19.0	12.0	B	-	24.0	-	2.0	15.0	B	-	23.0	-	5.0	16.0	B
766	6th Street S at Portland Avenue S	6.0	-	-	11.0	9.0	A	10.0	-	-	7.0	9.0	A	6.0	-	-	13.0	9.0	A
767	5th Street S at Portland Avenue S	-	7.0	-	14.0	11.0	B	-	6.0	-	10.0	9.0	A	-	3.0	-	23.0	19.0	B
768	4th Street S at Portland Avenue S	1.0	11.0	-	11.0	6.0	A	1.0	5.0	-	5.0	3.0	A	7.0	28.0	-	13.0	11.0	B
769	3rd Street S at Portland Avenue S	-	10.0	-	11.0	10.0	A	-	6.0	-	8.0	7.0	A	-	22.0	-	8.0	17.0	B
770	Washington Avenue S at Portland Avenue S	5.0	17.7	-	31.6	15.9	B	6.0	10.1	-	26.1	9.5	A	43.6	23.0	-	41.8	34.6	C
771	10th Street S at Park Avenue S	10.0	1.0	4.0	-	5.0	A	3.0	-	3.0	-	3.0	A	2.0	1.0	5.0	-	4.0	A
773	8th Street S at Park Avenue S	26.0	-	2.0	-	11.0	B	5.0	-	2.0	-	3.0	A	7.0	-	5.0	-	6.0	A
774	7th Street S at Park Avenue S	-	9.0	7.0	-	8.0	A	-	6.0	3.0	-	5.0	A	-	10.0	5.0	-	7.0	A
775	6th Street S at Park Avenue S	4.0	-	3.0	-	3.0	A	4.0	-	1.0	-	3.0	A	12.0	-	8.0	-	11.0	B
776	5th Street S at Park Avenue S	-	4.0	15.0	-	10.0	A	-	13.0	17.0	-	15.0	B	-	8.0	6.0	-	7.0	A
777	4th Street S at Park Avenue S	25.0	7.0	5.0	-	13.0	B	9.0	21.0	11.0	-	11.0	B	5.0	6.0	6.0	-	6.0	A
778	3rd Street S at Park Avenue S	-	25.0	1.0	-	12.0	B	-	5.0	5.0	-	5.0	A	-	16.0	2.0	-	9.0	A
780	19th Avenue S at Washington Avenue S	32.0	35.0	8.0	18.0	19.0	B	24.0	18.0	11.0	6.0	13.0	B	10.0	42.0	22.0	**60.0**	31.0	C
782	8th Street S at Chicago Avenue S	8.0	-	8.0	12.0	10.0	A	7.0	-	11.0	10.0	9.0	A	5.0	-	11.0	21.0	9.0	A
784	6th Street S at Chicago Avenue S	9.0	-	8.0	25.0	14.0	B	6.0	-	8.0	11.0	7.0	A	25.0	-	8.0	17.0	21.0	C
785	5th Street S at Chicago Avenue S	-	19.0	14.0	25.0	20.0	B	-	14.0	8.0	10.0	11.0	B	-	13.0	6.0	28.0	15.0	B
786	4th Street S at Chicago Avenue S	15.0	18.0	13.0	38.0	21.0	C	10.0	22.0	8.0	9.0	10.0	A	10.0	19.0	15.0	19.0	14.0	B
787	19th Avenue S at 3rd Street S	8.0	12.0	13.0	11.0	11.0	B	9.0	10.0	10.0	14.0	11.0	B	14.0	12.0	12.0	7.0	11.0	B
798	Riverside Avenue S at 19th Avenue S	7.0	15.0	27.0	39.0	23.0	C	13.0	7.0	18.0	27.0	15.0	B	17.0	12.0	29.0	28.0	18.0	B
799	Park Avenue S at 14th Street E	10.0	20.0	5.0	-	7.0	A	6.0	2.0	6.0	-	6.0	A	38.0	27.0	6.0	-	14.0	B
815	Cedar Avenue S at 2 1/2 Street	-	32.0	4.0	9.0	12.0	B	-	20.0	4.0	15.0	13.0	B	-	26.0	7.0	16.0	14.0	B
825	Riverside Avenue S at 23rd Avenue S	5.0	3.0	-	33.0	7.0	A	7.0	6.0	-	25.0	10.0	A	13.0	14.0	-	36.0	19.0	B
826	Riverside Avenue S at 20th Avenue S	12.0	9.0	19.0	15.0	13.0	B	14.0	14.0	15.0	13.0	14.0	B	33.0	15.0	24.0	17.0	24.0	C
852	Portland Avenue S at 16th Street E	-	36.0	-	1.0	2.0	A	-	39.0	-	2.0	4.0	A	-	47.0	-	2.0	3.0	A
868	Riverside Avenue S at 22nd Avenue S	5.0	1.0	26.0	27.0	5.0	A	4.0	4.0	17.0	22.0	6.0	A	5.0	5.0	33.0	29.0	8.0	A
908	2nd Street S at Marquette Avenue S	-	23.0	1.0	-	3.0	A	-	26.0	3.0	1.0	4.0	A	-	25.0	7.0	-	6.0	A
909	2nd Street S at 2nd Avenue S	10.0	25.0	14.0	5.0	13.0	B	4.0	13.0	15.0	5.0	10.0	A	4.0	9.0	17.0	21.0	16.0	B
926	Washington Avenue N at 3rd Avenue N	24.0	15.2	50.4	**91.1**	41.2	D	16.2	14.7	18.7	29.8	18.0	B	28.8	20.8	63.6	**95.4**	42.7	D
934	Hennepin Avenue S at Robert Fischer Drive S	-	32.5	2.5	18.8	12.3	B	-	26.4	2.6	4.4	4.0	A	-	31.7	3.1	48.2	24.2	C
944	Washington Avenue N at 5th Avenue N	9.0	8.0	19.0	28.0	12.0	B	6.0	3.0	22.0	30.0	8.0	A	10.0	9.0	19.0	28.0	13.0	B
947	Riverside Avenue S at 21st Avenue S	2.0	1.0	24.0	29.0	5.0	A	4.0	4.0	18.0	22.0	7.0	A	5.0	6.0	28.0	37.0	10.0	A
951	Washington Avenue N at 6th Avenue N	4.0	4.0	15.0	22.0	6.0	A	3.0	1.0	18.0	22.0	5.0	A	6.0	15.0	26.0	18.0	14.0	B
959	9th Street S at Park Avenue S	-	12.0	5.0	-	7.0	A	-	7.0	6.0	-	7.0	A	-	11.0	7.0	-	8.0	A
960	9th Street S at Portland Avenue S	-	11.0	-	2.0	6.0	A	-	8.0	-	5.0	6.0	A	-	21.0	-	5.0	11.0	B
961	9th Street S at 5th Avenue S	-	18.0	14.0	-	15.0	B	-	14.0	9.0	-	11.0	B	-	28.0	7.0	-	16.0	B
965	6th Street N at 2nd Avenue N	24.0	-	30.0	16.0	26.0	C	25.0	-	11.0	5.0	18.0	B	36.0	-	14.0	4.0	16.0	B
991	Cedar Avenue S at 7th Street S	20.0	**73.0**	7.0	5.0	37.0	D	12.0	44.0	11.0	14.0	25.0	C	16.0	43.0	8.0	4.0	16.0	B

= AM Peak, Mid-day and PM Peak delays computed using SimTraffic.

= Field Study Delays.

= ID 610: WB used for SW approach. ID 614: EB used for NW approach. ID 616: SB used for NW approach. ID 617: SB used for NE approach. ID 926: NB used for NW approach.

Appendix B:
Optimized Conditions LOS Analysis

Optimized Conditions Intersection Delay and LOS

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
10	8th Street S at 9th Avenue S	2.0	-	-	-	2.0	A	3.0	-	-	-	2.0	A	2.0	-	9.0	-	3.0	A
18	LaSalle Avenue S at Mid-Block	-	31.0	1.0	2.0	3.0	A	-	29.0	4.0	4.0	8.0	A	-	49.0	10.0	11.0	24.0	C
22	9th Street S at Chicago Avenue S	-	31.0	6.0	12.0	11.0	B	-	23.0	11.0	7.0	13.0	B	-	38.0	14.0	27.0	26.0	C
27	Chicago Avenue S at 17th Street E	-	19.0	8.0	7.0	11.0	B	-	33.0	6.0	2.0	12.0	B	-	19.0	8.0	8.0	11.0	B
30	Park Avenue S at 15th Street E	14.0	18.0	5.0	-	7.0	A	14.0	8.0	7.0	-	8.0	A	11.0	8.0	3.0	-	4.0	A
36	Portland Avenue S at 15th Street E	23.0	27.0	-	12.0	17.0	B	10.0	8.0	-	7.0	8.0	A	**63.0**	29.0	-	9.0	20.0	B
53	Lyndale Avenue N SB at Dunwoody Boulevard W	30.0	17.0	-	42.0	33.0	C	15.0	8.0	-	32.0	20.0	B	20.0	15.0	-	43.0	28.0	C
67	Washington Avenue S at 4th Avenue S	4.6	11.6	-	-	8.4	A	5.5	6.3	-	-	5.9	A	3.2	5.6	-	-	4.5	A
77	Cedar Avenue S at 6th Street S	6.0	8.0	10.0	12.0	10.0	A	11.0	14.0	7.0	7.0	8.0	A	33.0	23.0	7.0	8.0	13.0	B
84	Washington Avenue S at 13th Avenue S	10.9	12.2	-	**55.7**	32.3	C	8.2	**77.5**	-	41.2	32.5	C	25.1	**72.9**	-	30.0	34.2	C
85	Washington Avenue S at Park Avenue S	3.5	6.7	33.7	40.2	12.4	B	6.8	7.1	24.7	25.1	10.7	B	3.5	6.0	19.7	28.3	8.7	A
87	Washington Avenue S at 14th Avenue S	11.5	10.3	27.0	-	15.7	B	11.4	44.5	24.2	-	23.4	C	11.4	**62.5**	47.3	-	31.5	C
99	10th Street N at Currie Avenue W	1.0	-	22.0	48.0	2.0	A	3.0	-	10.0	36.0	8.0	A	13.0	-	-	50.0	23.0	C
103	3rd Street S at Chicago Avenue S	-	25.0	3.0	5.0	14.0	B	-	18.0	5.0	6.0	11.0	B	-	17.0	9.0	23.0	17.0	B
107	Dunwoody Boulevard W at Colfax Avenue S	22.0	4.0	**73.0**	20.0	23.0	C	7.0	2.0	13.0	16.0	8.0	A	13.0	3.0	45.0	35.0	13.0	B
110	Washington Avenue S at Chicago Avenue S	7.2	12.3	**58.6**	**75.4**	17.2	B	8.7	11.3	46.9	**59.8**	15.6	B	14.2	18.1	16.6	29.1	16.5	B
111	Washington Avenue S at 10th Avenue S	4.3	3.6	33.3	39.3	5.5	A	6.2	5.9	24.5	23.0	7.1	A	7.1	4.3	31.9	40.5	7.9	A
169	Chicago Avenue S at 14th Street E	14.0	14.0	6.0	4.0	8.0	A	15.0	29.0	4.0	2.0	12.0	B	27.0	17.0	3.0	4.0	11.0	B
200	6th Street S at 11th Avenue S	15.0	-	1.0	23.0	17.0	B	4.0	-	7.0	13.0	7.0	A	7.0	-	13.0	20.0	11.0	B
202	Cedar Avenue S at Riverside Avenue S	36.0	13.0	24.0	24.0	23.0	C	33.0	8.0	26.0	16.0	19.0	B	47.0	8.0	18.0	17.0	19.0	B
220	Cedar Avenue S at 5th Street	-	-	1.0	4.0	2.0	A	-	-	2.0	3.0	3.0	A	-	-	2.0	2.0	2.0	A
222	Washington Avenue S at Cedar Avenue S	8.0	11.0	23.0	26.0	12.0	B	16.0	15.0	18.0	23.0	17.0	B	34.0	34.0	27.0	30.0	33.0	C
223	15th Avenue S at Holiday Inn	1.0	5.0	-	21.0	4.0	A	2.0	9.0	-	16.0	6.0	A	3.0	6.0	-	15.0	6.0	A
234	Washington Avenue S at 11th Avenue S	10.0	17.1	**70.5**	48.0	30.7	C	9.3	11.6	24.0	**56.0**	18.2	B	25.2	34.9	15.5	40.7	27.9	C
239	7th Street N at 3rd Avenue N	-	1.0	-	-	1.0	A	-	**0**	-	-	-	**F**	-	1.0	-	-	1.0	A
240	10th Street N at 3rd Avenue N	6.0	-	-	24.0	7.0	A	4.0	-	-	13.0	6.0	A	5.0	-	-	22.0	10.0	A
241	10th Street N at Glenwood Avenue N	24.0	18.0	-	22.0	22.0	C	23.0	30.0	-	5.0	12.0	B	52.0	20.0	-	12.0	25.0	C
245	Lyndale Avenue S at Vineland Place/Oak Grove Street	**85.0**	**108.0**	23.3	31.2	37.5	D	32.0	**61.0**	15.3	22.1	22.8	C	**87.0**	**198.0**	28.5	45.3	47.0	D
252	Lyndale Avenue S at Groveland Avenue/Hennepin Avenue	**113.0**	**105.0**	22.6	13.7	30.0	C	**62.0**	41.0	18.5	14.4	19.3	B	**91.0**	**108.0**	21.0	18.7	44.1	D
253	Lyndale Avenue S at Ramp D	43.7	50.8	45.9	-	46.4	D	40.8	38.7	24.8	-	33.8	C	53.2	51.2	27.6	-	39.9	D
258	5th Street N at 3rd Avenue N	49.0	7.0	-	26.0	30.0	C	40.0	18.0	-	25.0	27.0	C	**58.0**	14.0	-	23.0	32.0	C
289	3rd Avenue S at 16th Street E	23.0	16.0	17.0	31.0	23.0	C	13.0	11.0	7.0	13.0	11.0	B	16.0	24.0	46.0	24.0	30.0	C
304	Park Avenue S at 16th Street E	30.0	22.0	11.0	-	12.0	B	34.0	10.0	10.0	-	11.0	B	10.0	6.0	16.0	-	15.0	B
325	5th Street S at 11th Avenue S	-	29.0	26.0	48.0	33.0	C	23.0	14.0	16.0	23.0	16.0	B	55.0	31.0	17.0	16.0	23.0	C
357	7th Street S at 11th Avenue S	-	30.0	24.0	20.0	25.0	C	-	17.0	10.0	2.0	11.0	B	-	42.0	11.0	2.0	19.0	B
366	5th Street N at 5th Avenue N	5.0	4.0	-	20.0	6.0	A	4.0	3.0	-	25.0	8.0	A	9.0	7.0	-	32.0	12.0	B
392	11th Avenue S at 14th Street E	7.0	-	11.0	10.0	10.0	A	14.0	-	10.0	6.0	9.0	A	41.0	-	7.0	4.0	14.0	B
393	8th Street S at 11th Avenue S	15.0	-	8.0	9.0	11.0	B	7.0	-	8.0	12.0	8.0	A	14.0	-	22.0	16.0	16.0	B
418	3rd Avenue S at 14th Street E	-	27.0	1.0	-	1.0	A	-	19.0	1.0	-	1.0	A	-	24.0	7.0	1.0	3.0	A
422	16th Street E at 4th Avenue S	1.0	1.0	-	-	1.0	A	3.0	1.0	-	-	2.0	A	5.0	1.0	-	-	3.0	A
423	15th Street E at 4th Avenue S	-	13.0	6.0	13.0	12.0	B	6.0	10.0	28.0	23.0	17.0	B	7.0	30.0	38.0	48.0	36.0	D
434	Cedar Avenue S at 3rd Street	-	-	7.0	3.0	4.0	A	-	-	16.0	9.0	12.0	B	-	-	11.0	8.0	9.0	A
443	Washington Avenue N at 2nd Avenue N	12.3	4.5	**107.2**	25.1	31.3	C	10.7	4.7	33.4	28.2	13.7	B	16.5	8.3	33.9	40.5	18.4	B
546	2nd Street N at 3rd Avenue N	14.0	13.0	12.0	12.0	12.0	B	9.0	9.0	7.0	10.0	9.0	A	17.0	23.0	18.0	28.0	22.0	C
570	6th Street S at Mid-Block	9.0	-	-	**58.0**	10.0	A	20.0	-	-	43.0	20.0	B	10.0	-	-	**66.0**	12.0	B
579	7th Street S at Chicago Avenue S	-	22.0	20.0	12.0	20.0	B	-	12.0	11.0	10.0	11.0	B	-	30.0	11.0	8.0	20.0	B
607	2nd Avenue S at Convention Center West	1.0	1.0	-	-	1.0	A	4.0	-	-	-	1.0	A	2.0	-	-	-	1.0	A
608	2nd Avenue S at Convention Center East	1.0	-	-	-	3.0	A	6.0	-	-	-	6.0	A	2.0	-	-	-	2.0	A
609	7th Street S at Mid-Block	-	-	-	-	-	**F**	-	1.0	-	-	1.0	A	-	1.0	-	-	1.0	A
610	12th Street N at Glenwood Avenue N	21.0	-	25.0	11.0	21.0	C	8.0	-	11.0	10.0	10.0	A	21.0	-	15.0	10.0	20.0	B
612	1st Street S at 2nd Avenue S	-	7.0	31.0	-	12.0	B	-	3.0	32.0	-	11.0	B	-	5.0	38.0	-	11.0	B
613	9th Street N at Glenwood Avenue N	8.0	14.0	21.0	-	16.0	B	12.0	14.0	24.0	-	20.0	B	15.0	21.0	9.0	-	13.0	B
614	7th Street N at 2nd Avenue N	-	19.0	17.0	-	19.0	B	-	9.0	8.0	-	11.0	B	-	30.0	11.0	-	38.0	D
616	5th Street N at 2nd Avenue N	**116.0**	22.0	45.0	-	**57.0**	**E**	**71.0**	19.0	30.0	-	39.0	D	**126.0**	22.0	28.0	-	55.0	D
617	4th Street N at 2nd Avenue N	50.0	-	24.0	-	**59.0**	**E**	23.0	-	21.0	-	27.0	C	22.0	-	23.0	-	27.0	C
618	3rd Street N at 2nd Avenue N	-	11.0	14.0	-	12.0	B	-	4.0	13.0	-	7.0	A	-	13.0	21.0	-	15.0	B
622	12th Street N at Currie Avenue W	1.0	2.0	32.0	-	3.0	A	3.0	2.0	21.0	-	4.0	A	1.0	1.0	38.0	-	2.0	A
625	1st Avenue N at 8th Street N & 9th Street N	27.6	-	7.8	19.9	14.2	B	16.1	-	9.9	13.0	11.9	B	29.9	-	36.5	15.1	25.4	C
626	7th Street N at 1st Avenue N	-	12.3	6.8	3.1	7.9	A	-	10.9	6.3	5.7	8.7	A	-	12.4	11.3	14.5	12.8	B
627	6th Street N at 1st Avenue N	20.4	-	13.0	14.8	17.5	B	11.7	-	5.0	13.3	11.0	B	17.9	-	18.8	9.7	14.9	B
628	5th Street N at 1st Avenue N	-	10.8	16.2	18.8	17.6	B	-	23.4	21.7	24.8	24.0	C	-	18.1	20.4	15.5	17.4	B
629	4th Street N at 1st Avenue N	10.3	-	18.3	11.0	10.7	B	9.5	-	11.3	11.7	10.3	B	12.9	-	13.7	16.5	14.1	B
630	3rd Street N at 1st Avenue N	-	9.5	17.6	15.1	12.1	B	-	7.5	11.2	13.3	9.5	A	-	9.9	53.8	16.0	16.0	B
631	Washington Avenue N at 1st Avenue N	12.2	20.4	**55.8**	44.5	22.1	C	16.8	8.6	22.5	20.8	14.5	B	19.6	22.8	33.0	36.2	24.5	C
633	1st Avenue N at 2nd Street N	6.2	18.4	20.3	24.1	16.0	B	13.4	19.3	8.6	13.2	14.6	B	22.7	33.7	9.9	19.2	23.7	C
635	12th Street N at Hawthorne Avenue W	38.5	-	**100.6**	6.6	**74.2**	**E**	23.5	-	6.9	5.4	7.8	A	39.2	-	7.6	7.7	12.6	B
637	10th Street N at Hawthorne Avenue W	19.7	-	25.2	38.6	24.8	C	16.0	-	5.4	8.7	10.4	B	**68.7**	-	6.4	13.6	35.9	D
638	9th Street N at Hawthorne Avenue W	-	19.0	8.3	13.0	13.1	B	-	7.4	8.7	6.7	7.4	A	-	15.1	41.7	11.2	18.6	B
641	Hennepin Avenue S at Dunwoody Boulevard W	13.7	21.3	28.4	19.1	24.3	C	13.3	21.9	8.5	24.3	12.0	B	15.8	21.3	10.7	25.1	14.5	B
642	Hennepin Avenue S at Maple & 16th Street N	13.7	29.4	5.0	11.1	7.0	A	19.7	21.5	5.2	16.3	11.2	B	23.4	31.8	12.8	21.4	18.4	B
644	Hennepin Avenue S at Spruce Place	29.3	30.4	4.9	9.6	8.7	A	17.4	17.7	10.5	13.8	12.9	B	27.2	**81.5**	14.8	5.2	20.3	C
645	Hennepin Avenue S at 13th Street N	39.7	39.1	2.5	6.1	6.0	A	19.5	22.7	6.5	6.1	8.0	A	35.9	44.2	5.4	4.2	9.0	A
646	Hennepin Avenue S at 12th Street N	26.8	-	9.9	10.4	17.9	B	18.6	-	7.0	6.4	11.3	B	25.2	-	12.8	11.4	16.5	B
647	Hennepin Avenue S at 11th Street N	-	**55.8**	9.3	11.7	26.8	C	-	14.3	7.6	5.3	9.8	A	-	43.1	8.9	10.0	25.7	C
648	Hennepin Avenue S at 10th Street N	41.0	-	17.8	8.2	28.2	C	13.7	-	9.7	15.4	12.8	B	21.9	-	7.2	7.1	12.8	B
649	Hennepin Avenue S at 9th Street N	-	28.8	10.9	5.5	15.1	B	-	13.4	6.2	6.1	9.3	A	-	33.8	12.0	7.4	21.8	C
650	Hennepin Avenue S at 8th Street N	27.7	-	10.9	16.4	17.3	B	31.0	-	6.9	22.8	16.9	B	36.9	-	8.8	7.0	13.1	B
651	Hennepin Avenue S at 7th Street N	-	27.2	4.2	4.7	13.6	B	-	19.1	6.8	19.9	15.7	B	-	38.7	11.7	12.4	25.8	C
652	Hennepin Avenue S at 6th Street N	24.3	-	22.3	17.5	22.1	C	17.4	-	7.8	9.7	11.5	B	24.6	-	19.5	6.4	16.9	B
653	Hennepin Avenue S at 5th Street N/5th Street S	-	24.2	12.7	6.8	11.6	B	-	26.9	13.1	7.9	12.7	B	-	11.3	28.6	11.0	19.1	B
654	Hennepin Avenue S at 4th Street N	16.5	2.7	23.9	11.5	16.7	B	9.2	5.3	6.4	6.6	7.6	A	24.4	17.0	11.1	7.7	15.2	B
655	Hennepin Avenue S at 3rd Street N	-	17.4	11.6	7.0	12.3	B	-	10.5	15.3	17.4	13.9	B	-	6.7	37.5	15.3	16.4	B
656	Hennepin Avenue S at Washington Avenue N	27.8	44.4	36.8	9.9	28.8	C	35.2	11.3	29.5	22.4	25.1	C	36.3	24.3	29.1	**56.7**	35.4	D
657	Hennepin Avenue S at 2nd Street N	19.3	-	12.6	2.6	7.9	A	29.9	-	4.7	1.9	5.9	A	32.6	-	6.1	4.9	10.7	B
658	Hennepin Avenue S at 1st Street N	34.7	12.8	30.2	25.9	26.9	C	22.6	8.4	18.4	21.2	18.6	B	42.1	17.5	24.4	24.7	25.7	C

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
664	12th Street S at 3rd Avenue S	11.0	-	27.0	17.0	15.0	B	9.0	-	19.0	18.0	14.0	B	20.0	-	26.0	17.0	20.0	B
666	12th Street S at Harmon Place S	4.0	-	20.0	27.0	7.0	A	5.0	-	9.0	21.0	7.0	A	14.0	-	10.0	29.0	17.0	B
667	11th Street S at Harmon Place S	-	3.0	42.0	28.0	13.0	B	-	5.0	13.0	4.0	6.0	A	-	7.0	23.0	18.0	9.0	A
668	10th Street S at Harmon Place S	7.0	-	6.0	-	7.0	A	4.0	-	1.0	-	4.0	A	4.0	-	-	-	3.0	A
675	Grant Street W at LaSalle Avenue S	32.0	17.0	-	10.0	19.0	B	10.0	10.0	-	12.0	11.0	B	29.0	17.0	-	26.0	24.0	C
676	19th Avenue S at 2nd Street S	31.0	50.0	3.0	15.0	17.0	B	29.0	42.0	3.0	9.0	10.0	A	31.0	52.0	5.0	6.0	11.0	B
677	12th Street S at LaSalle Avenue S	9.0	-	13.0	25.0	11.0	B	7.0	-	12.0	12.0	9.0	A	45.0	-	15.0	4.0	27.0	C
678	11th Street S at LaSalle Avenue S	-	24.0	14.0	19.0	20.0	B	-	4.0	9.0	7.0	6.0	A	-	12.0	43.0	28.0	21.0	C
679	10th Street S at LaSalle Avenue S	13.0	-	41.0	21.0	21.0	C	12.0	-	20.0	23.0	16.0	B	38.0	-	17.0	14.0	25.0	C
680	9th Street S at LaSalle Avenue S	-	1.0	24.0	18.0	9.0	A	-	3.0	5.0	8.0	4.0	A	-	2.0	43.0	55.0	17.0	B
681	8th Street S at LaSalle Avenue S	7.0	-	7.0	30.0	7.0	A	21.0	-	1.0	15.0	15.0	B	16.0	-	4.0	43.0	17.0	B
682	Nicollet Avenue S at Grant Street W	13.0	10.0	27.0	23.0	16.0	B	12.0	8.0	16.0	11.0	12.0	B	14.0	6.0	33.0	25.0	16.0	B
683	13th Street S at Nicollet Mall	-	22.0	6.0	1.0	8.0	A	-	22.0	5.0	2.0	8.0	A	-	25.0	9.0	**0**	10.0	A
684	12th Street S at Nicollet Mall	6.0	-	18.0	38.0	8.0	A	12.0	-	11.0	20.0	13.0	B	14.0	-	17.0	26.0	15.0	B
685	11th Street S at Nicollet Mall	-	10.0	20.0	24.0	11.0	B	-	11.0	1.0	3.0	9.0	A	-	6.0	11.0	27.0	7.0	A
686	10th Street S at Nicollet Mall	19.0	-	34.0	18.0	20.0	B	10.0	-	9.0	8.0	10.0	A	14.0	-	46.0	14.0	17.0	B
687	9th Street S at Nicollet Mall	-	9.0	2.0	33.0	10.0	A	-	12.0	9.0	1.0	11.0	B	-	19.0	22.0	11.0	19.0	B
688	8th Street S at Nicollet Mall	18.0	-	6.0	5.0	16.0	B	14.0	-	**0**	22.0	14.0	B	14.0	-	2.0	16.0	13.0	B
689	7th Street S at Nicollet Mall	-	13.0	25.0	52.0	15.0	B	-	10.0	33.0	16.0	12.0	B	-	9.0	52.0	33.0	12.0	B
690	6th Street S at Nicollet Mall	2.0	-	20.0	14.0	3.0	A	16.0	-	8.0	8.0	15.0	B	11.0	-	7.0	5.0	10.0	A
691	5th Street S at Nicollet Mall	-	38.0	54.0	34.0	40.0	D	-	36.0	17.0	8.0	26.0	C	-	55.0	42.0	10.0	47.0	D
692	4th Street S at Nicollet Mall	21.0	11.0	11.0	12.0	20.0	B	8.0	7.0	12.0	17.0	9.0	A	10.0	11.0	4.0	8.0	10.0	A
693	3rd Street S at Nicollet Mall	-	22.0	27.0	16.0	22.0	C	-	8.0	7.0	17.0	8.0	A	-	12.0	11.0	9.0	12.0	B
694	Washington Avenue S at Nicollet Mall	2.5	46.4	51.2	-	21.8	C	4.0	4.7	11.6	-	4.5	A	4.1	13.4	26.3	-	9.4	A
695	Grant Street E at Marquette Avenue S	28.0	10.0	17.0	15.0	17.0	B	16.0	7.0	10.0	-	10.0	A	16.0	6.0	24.0	10.0	12.0	B
696	13th Street S at Marquette Avenue S	11.0	-	1.0	4.0	3.0	A	35.0	-	3.0	2.0	8.0	A	7.0	-	2.0	2.0	3.0	A
697	12th Street S at Marquette Avenue S	1.0	-	25.0	9.0	9.0	A	-	-	13.0	4.0	5.0	A	-	-	18.0	6.0	6.0	A
698	11th Street S at Marquette Avenue S	-	12.0	18.0	46.0	17.0	B	-	6.0	13.0	9.0	8.0	A	-	26.0	6.0	14.0	22.0	C
699	10th Street S at Marquette Avenue S	2.0	-	10.0	1.0	5.0	A	6.0	-	7.0	13.0	7.0	A	2.0	-	30.0	13.0	11.0	B
700	9th Street S at Marquette Avenue S	-	19.0	18.0	33.0	20.0	B	-	8.0	15.0	8.0	11.0	B	-	16.0	12.0	43.0	17.0	B
701	8th Street S at Marquette Avenue S	6.0	-	9.0	3.0	7.0	A	3.0	-	12.0	26.0	8.0	A	11.0	-	7.0	26.0	11.0	B
702	7th Street S at Marquette Avenue S	-	17.0	14.0	3.0	15.0	B	-	10.0	9.0	9.0	9.0	A	-	28.0	26.0	5.0	25.0	C
703	6th Street S at Marquette Avenue S	12.0	-	18.0	2.0	13.0	B	2.0	-	10.0	19.0	5.0	A	12.0	-	14.0	1.0	11.0	B
704	5th Street S at Marquette Avenue S	-	**143.0**	27.0	25.0	**57.0**	**E**	-	42.0	48.0	18.0	45.0	D	-	**127.0**	47.0	3.0	55.0	D
705	4th Street S at Marquette Avenue S	9.0	19.0	15.0	19.0	11.0	B	1.0	15.0	5.0	7.0	3.0	A	7.0	42.0	11.0	10.0	10.0	A
706	3rd Street S at Marquette Avenue S	-	12.0	9.0	12.0	11.0	B	-	3.0	8.0	10.0	6.0	A	-	13.0	34.0	14.0	20.0	B
707	Washington Avenue S at Marquette Avenue S	4.0	16.9	30.7	42.7	14.2	B	7.5	3.2	51.5	27.4	14.8	B	11.5	10.6	39.1	31.0	18.0	B
709	1st Street S at Marquette Avenue S	13.0	7.0	19.0	-	12.0	B	11.0	4.0	16.0	-	10.0	A	19.0	10.0	15.0	-	14.0	B
711	12th Street S at 2nd Avenue S	4.0	-	**57.0**	29.0	13.0	B	5.0	-	36.0	13.0	11.0	B	25.0	-	**62.0**	25.0	27.0	C
712	11th Street S at 2nd Avenue S	-	9.0	16.0	13.0	10.0	A	-	3.0	6.0	5.0	4.0	A	-	13.0	7.0	22.0	16.0	B
713	10th Street S at 2nd Avenue S	8.0	-	13.0	22.0	13.0	B	3.0	-	12.0	6.0	4.0	A	9.0	-	13.0	17.0	12.0	B
714	9th Street S at 2nd Avenue S	-	11.0	3.0	17.0	12.0	B	-	5.0	6.0	16.0	10.0	A	-	16.0	2.0	6.0	10.0	A
715	8th Street S at 2nd Avenue S	11.0	-	2.0	7.0	9.0	A	9.0	-	6.0	11.0	9.0	A	24.0	-	9.0	10.0	17.0	B
716	7th Street S at 2nd Avenue S	-	26.0	19.0	12.0	21.0	C	-	6.0	5.0	20.0	11.0	B	-	20.0	35.0	25.0	22.0	C
717	6th Street S at 2nd Avenue S	14.0	-	27.0	4.0	12.0	B	5.0	-	7.0	2.0	4.0	A	17.0	-	16.0	4.0	14.0	B
718	5th Street S at 2nd Avenue S	-	14.0	21.0	34.0	30.0	C	-	6.0	24.0	18.0	16.0	B	-	15.0	17.0	29.0	24.0	C
719	4th Street S at 2nd Avenue S	3.0	20.0	18.0	16.0	8.0	A	5.0	12.0	1.0	19.0	8.0	A	13.0	35.0	**0**	13.0	12.0	B
720	3rd Street S at 2nd Avenue S	-	23.0	21.0	14.0	20.0	B	-	28.0	8.0	7.0	21.0	C	-	13.0	2.0	24.0	14.0	B
721	Washington Avenue S at 2nd Avenue S	4.1	10.4	28.1	37.1	12.8	B	13.1	4.4	22.9	17.0	10.1	B	15.5	5.5	24.2	39.0	14.8	B
724	11th Street N at Hawthorne Avenue W	-	42.6	16.7	3.6	22.3	C	-	13.3	10.7	4.3	8.8	A	-	17.9	21.7	16.0	17.5	B
726	11th Street S at 3rd Avenue S	-	7.0	16.0	18.0	10.0	A	-	10.0	5.0	10.0	9.0	A	-	17.0	9.0	7.0	13.0	B
727	10th Street S at 3rd Avenue S	11.0	-	17.0	5.0	12.0	B	8.0	-	12.0	11.0	10.0	A	21.0	-	21.0	28.0	22.0	C
728	9th Street S at 3rd Avenue S	-	31.0	7.0	25.0	22.0	C	-	12.0	6.0	16.0	11.0	B	-	11.0	10.0	13.0	11.0	B
729	8th Street S at 3rd Avenue S	10.0	-	10.0	10.0	10.0	A	32.0	-	3.0	4.0	16.0	B	22.0	-	10.0	21.0	18.0	B
730	7th Street S at 3rd Avenue S	-	16.0	10.0	13.0	14.0	B	-	14.0	8.0	17.0	13.0	B	-	15.0	8.0	11.0	12.0	B
731	6th Street S at 3rd Avenue S	9.0	-	11.0	5.0	9.0	A	19.0	-	9.0	1.0	11.0	B	28.0	-	10.0	3.0	17.0	B
732	5th Street S at 3rd Avenue S	-	-	37.0	**114.0**	**90.0**	**F**	-	-	10.0	21.0	15.0	B	-	-	37.0	**58.0**	45.0	D
733	4th Street S at 3rd Avenue S	12.0	17.0	7.0	6.0	9.0	A	8.0	9.0	1.0	7.0	6.0	A	19.0	29.0	9.0	4.0	12.0	B
734	3rd Street S at 3rd Avenue S	-	6.0	6.0	11.0	8.0	A	-	5.0	9.0	7.0	7.0	A	-	27.0	9.0	10.0	17.0	B
735	Washington Avenue S at 3rd Avenue S	15.6	49.6	26.4	21.6	28.2	C	7.7	12.9	30.9	16.3	15.3	B	18.0	35.5	33.8	36.7	30.7	C
736	2nd Street S at 3rd Avenue S	32.0	35.0	8.0	6.0	11.0	B	24.0	31.0	8.0	7.0	12.0	B	33.0	55.0	20.0	4.0	22.0	C
737	1st Street S at 3rd Avenue S	14.0	**62.0**	11.0	32.0	27.0	C	20.0	30.0	5.0	14.0	13.0	B	52.0	**85.0**	16.0	38.0	38.0	D
740	11th Street S at 4th Avenue S	-	32.0	23.0	35.0	32.0	C	-	11.0	9.0	4.0	10.0	A	-	11.0	15.0	8.0	11.0	B
741	10th Street S at 4th Avenue S	9.0	-	-	9.0	9.0	A	8.0	-	-	9.0	8.0	A	14.0	-	-	23.0	19.0	B
742	9th Street S at 4th Avenue S	-	15.0	-	32.0	20.0	B	-	10.0	-	5.0	7.0	A	-	12.0	-	21.0	18.0	B
743	8th Street S at 4th Avenue S	9.0	-	-	6.0	7.0	A	25.0	-	-	3.0	16.0	B	17.0	-	-	14.0	16.0	B
744	7th Street S at 4th Avenue S	-	10.0	-	5.0	9.0	A	-	6.0	-	4.0	5.0	A	-	13.0	-	5.0	9.0	A
745	6th Street S at 4th Avenue S	10.0	-	-	11.0	11.0	B	9.0	-	-	14.0	11.0	B	10.0	-	-	5.0	7.0	A
746	5th Street S at 4th Avenue S	-	7.0	-	25.0	21.0	C	-	4.0	-	12.0	9.0	A	-	4.0	-	49.0	42.0	D
747	4th Street S at 4th Avenue S	8.0	2.0	-	5.0	7.0	A	25.0	16.0	-	11.0	19.0	B	2.0	5.0	-	6.0	4.0	A
748	3rd Street S at 4th Avenue S	-	14.0	-	19.0	16.0	B	-	9.0	-	9.0	9.0	A	-	8.0	-	23.0	13.0	B
752	10th Street S at 5th Avenue S	22.0	-	23.0	-	23.0	C	35.0	-	10.0	-	19.0	B	23.0	-	24.0	-	24.0	C
754	8th Street S at 5th Avenue S	21.0	-	3.0	-	8.0	A	3.0	-	4.0	-	4.0	A	17.0	-	8.0	-	13.0	B
755	7th Street S at 5th Avenue S	-	9.0	8.0	-	8.0	A	-	4.0	8.0	-	6.0	A	-	4.0	9.0	-	7.0	A
756	6th Street S at 5th Avenue S	9.0	-	7.0	-	8.0	A	7.0	-	7.0	-	7.0	A	10.0	-	7.0	-	9.0	A
757	5th Street S at 5th Avenue S	-	11.0	36.0	-	27.0	C	-	11.0	7.0	-	9.0	A	-	3.0	20.0	-	18.0	B
758	4th Street S at 5th Avenue S	7.0	24.0	6.0	-	7.0	A	6.0	7.0	4.0	-	5.0	A	11.0	27.0	4.0	-	7.0	A
759	3rd Street S at 5th Avenue S	-	3.0	8.0	-	6.0	A	-	4.0	5.0	-	4.0	A	-	11.0	2.0	-	6.0	A

System ID	Intersection	AM Peak Hour						Mid-day Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
760	Washington Avenue S at 5th Avenue S	7.5	8.1	24.2	36.3	14.0	B	12.9	7.4	16.6	20.0	12.1	B	12.4	12.7	16.1	**57.6**	16.7	B
761	Portland Avenue S at Grant Street E	13.0	10.0	-	9.0	11.0	B	8.0	10.0	-	6.0	7.0	A	29.0	28.0	-	7.0	14.0	B
762	10th Street S at Portland Avenue S	6.0	-	-	7.0	7.0	A	2.0	-	-	6.0	5.0	A	5.0	-	-	15.0	12.0	B
764	8th Street S at Portland Avenue S	8.0	-	-	10.0	9.0	A	3.0	-	-	5.0	4.0	A	27.0	-	-	15.0	20.0	B
765	7th Street S at Portland Avenue S	-	22.0	-	7.0	17.0	B	-	6.0	-	1.0	4.0	A	-	21.0	-	15.0	19.0	B
766	6th Street S at Portland Avenue S	5.0	-	-	11.0	8.0	A	6.0	-	-	5.0	6.0	A	9.0	-	-	10.0	10.0	A
767	5th Street S at Portland Avenue S	-	9.0	-	14.0	12.0	B	-	2.0	-	22.0	15.0	B	-	34.0	-	10.0	16.0	B
768	4th Street S at Portland Avenue S	10.0	13.0	-	5.0	8.0	A	1.0	8.0	-	4.0	3.0	A	13.0	10.0	-	7.0	9.0	A
769	3rd Street S at Portland Avenue S	-	19.0	-	17.0	18.0	B	-	12.0	-	12.0	12.0	B	-	17.0	-	35.0	24.0	C
770	Washington Avenue S at Portland Avenue S	3.3	7.0	-	46.4	12.1	B	4.6	8.5	-	32.0	8.8	A	6.7	4.9	-	43.3	10.8	B
771	10th Street S at Park Avenue S	21.0	-	3.0	-	6.0	A	2.0	-	4.0	-	3.0	A	14.0	-	4.0	-	7.0	A
773	8th Street S at Park Avenue S	28.0	-	4.0	-	13.0	B	4.0	-	3.0	-	3.0	A	7.0	-	14.0	-	10.0	A
774	7th Street S at Park Avenue S	-	8.0	11.0	-	9.0	A	-	8.0	12.0	-	10.0	A	-	10.0	5.0	-	7.0	A
775	6th Street S at Park Avenue S	23.0	-	2.0	-	12.0	B	13.0	-	2.0	-	9.0	A	18.0	-	6.0	-	13.0	B
776	5th Street S at Park Avenue S	-	1.0	33.0	-	20.0	B	-	10.0	13.0	-	12.0	B	-	2.0	31.0	-	24.0	C
777	4th Street S at Park Avenue S	5.0	4.0	4.0	-	5.0	A	20.0	4.0	-	-	7.0	A	10.0	5.0	2.0	-	5.0	A
778	3rd Street S at Park Avenue S	-	11.0	4.0	-	7.0	A	-	6.0	4.0	-	5.0	A	-	19.0	2.0	-	10.0	A
780	19th Avenue S at Washington Avenue S	28.0	45.0	6.0	6.0	12.0	B	35.0	44.0	9.0	14.0	20.0	B	21.0	53.0	11.0	21.0	20.0	B
782	8th Street S at Chicago Avenue S	9.0	-	11.0	11.0	10.0	A	9.0	-	11.0	8.0	9.0	A	6.0	-	13.0	23.0	10.0	A
784	6th Street S at Chicago Avenue S	7.0	-	6.0	11.0	8.0	A	5.0	-	10.0	7.0	6.0	A	13.0	-	12.0	38.0	17.0	B
785	5th Street S at Chicago Avenue S	-	32.0	5.0	23.0	25.0	C	-	7.0	12.0	9.0	9.0	A	-	35.0	6.0	7.0	16.0	B
786	4th Street S at Chicago Avenue S	17.0	26.0	28.0	18.0	19.0	B	9.0	26.0	19.0	8.0	13.0	B	32.0	26.0	8.0	14.0	21.0	C
787	19th Avenue S at 3rd Street S	12.0	18.0	7.0	6.0	8.0	A	14.0	15.0	13.0	8.0	12.0	B	22.0	18.0	14.0	7.0	14.0	B
798	Riverside Avenue S at 19th Avenue S	24.0	14.0	27.0	23.0	20.0	B	14.0	8.0	30.0	19.0	14.0	B	25.0	16.0	27.0	19.0	20.0	B
799	Park Avenue S at 14th Street E	12.0	28.0	5.0	-	8.0	A	24.0	9.0	4.0	-	9.0	A	51.0	18.0	13.0	-	20.0	B
815	Cedar Avenue S at 2 1/2 Street	41.0	40.0	3.0	5.0	12.0	B	-	31.0	2.0	5.0	10.0	A	27.0	32.0	5.0	9.0	12.0	B
825	Riverside Avenue S at 23rd Avenue S	2.0	6.0	-	42.0	8.0	A	4.0	9.0	-	38.0	13.0	B	21.0	22.0	-	46.0	27.0	C
826	Riverside Avenue S at 20th Avenue S	10.0	7.0	33.0	34.0	15.0	B	32.0	30.0	17.0	28.0	28.0	C	31.0	10.0	31.0	**60.0**	26.0	C
852	Portland Avenue S at 16th Street E	-	41.0	-	1.0	3.0	A	-	29.0	-	1.0	3.0	A	-	50.0	-	2.0	3.0	A
908	2nd Street S at Marquette Avenue S	-	15.0	2.0	1.0	3.0	A	-	15.0	1.0	2.0	3.0	A	-	14.0	4.0	3.0	5.0	A
909	2nd Street S at 2nd Avenue S	5.0	14.0	-	7.0	8.0	A	4.0	14.0	-	12.0	10.0	A	5.0	8.0	-	12.0	10.0	A
926	Washington Avenue N at 3rd Avenue N	28.4	22.5	34.7	**63.6**	34.8	C	13.2	9.5	23.2	45.4	18.4	B	38.6	29.8	160.8	**91.7**	**68.1**	**E**
934	Hennepin Avenue S at Robert Fischer Drive S	-	**64.3**	3.8	17.5	12.8	B	-	33.0	2.2	3.9	3.6	A	-	**59.8**	4.3	16.7	11.2	B
944	Washington Avenue N at 5th Avenue N	7.0	6.0	24.0	38.0	12.0	B	6.0	8.0	24.0	34.0	11.0	B	8.0	6.0	24.0	38.0	13.0	B
947	Riverside Avenue S at 21st Avenue S	4.0	5.0	31.0	38.0	8.0	A	4.0	6.0	26.0	39.0	11.0	B	6.0	4.0	42.0	55.0	12.0	B
951	Washington Avenue N at 6th Avenue N	3.0	2.0	19.0	28.0	5.0	A	3.0	1.0	20.0	25.0	5.0	A	6.0	4.0	44.0	23.0	11.0	B
959	9th Street S at Park Avenue S	-	27.0	3.0	-	8.0	A	-	9.0	6.0	-	7.0	A	-	21.0	5.0	-	10.0	A
960	9th Street S at Portland Avenue S	-	21.0	-	3.0	11.0	B	-	6.0	-	9.0	8.0	A	-	16.0	-	6.0	10.0	A
961	9th Street S at 5th Avenue S	-	17.0	5.0	-	8.0	A	-	7.0	7.0	-	7.0	A	-	11.0	4.0	-	7.0	A
965	6th Street N at 2nd Avenue N	33.0	-	7.0	1.0	22.0	C	30.0	-	4.0	6.0	18.0	B	47.0	-	4.0	10.0	13.0	B
991	Cedar Avenue S at 7th Street S	16.0	28.0	13.0	15.0	21.0	C	9.0	20.0	16.0	13.0	16.0	B	15.0	29.0	12.0	8.0	15.0	B

= AM Peak, Mid-day and PM Peak delays computed using SimTraffic.

= Field Study Delays.

= ID 610: WB used for SW approach. ID 614: EB used for NW approach. ID 616: SB used for NW approach. ID 617: SB used for NE approach. ID 926: NB used for NW approach.

Appendix C:
Benefit/Cost Analysis

Traffic Volume Cases and TOD Signal Timing Plans

Final TOD/Volume Case

CBD

Tab	Time	Group 1 Henn, 1st, 2nd	Group 2 Henn/Lyn	Group 3: CBD Core	Group 4: Wash	Group 5: W end of 5th St	Group 6: W end of 12th St	Group 7: Cedar/River	Group 8: Henn, 1st 2nd	Group 9: Dunwody/Col	Volume Description	Hours/ day
	2300-600	111	121	111	121	004	111	121	121	121		
1a	600-615	111	121	111	111	004	111	121	121	121	PM OFF 2	0.25
2a	615-630	111	121	111	111	004	111	121	111	111	PM OFF 2	0.25
3a	630-645	111	211	111	111	004	111	121	111	111	AM OFF	0.25
4a	645-715	211	211	211	211	211	211	121	211	211	AM OFF	0.5
5a	**715-845**	**211**	**211**	**211**	**211**	**211**	**211**	**211**	**211**	**211**	**AM PEAK**	**1.5**
6a	845-900	211	211	211	211	211	211	211	211	211	AM OFF	0.25
7a	900-930	111	111	111	111	111	111	131	121	121	AM OFF	0.5
8a	930-1115	111	111	111	111	111	111	131	121	121	MID LOW	1.75
9a	**1115-1500**	**111**	**111**	**111**	**111**	**111**	**111**	**111**	**121**	**121**	**MID PEAK**	**3.75**
10a	1500-1515	311	311	111	311	311	111	311	311	311	PM OFF 1	0.25
11a	1515-1600	311	311	311	311	311	311	311	311	311	PM OFF 1	0.75
12a	**1600-1745**	**311**	**311**	**311**	**311**	**311**	**311**	**311**	**311**	**311**	**PM PEAK**	**1.75**
11a	1745-1800	311	311	311	311	311	311	311	311	311	PM OFF 1	0.25
13a	1800-1815	311	311	311	311	311	311	131	311	311	PM OFF 1	0.25
14a	1815-1830	111	311	111	111	111	111	131	111	111	MID PEAK	0.25
15a	1830-1900	111	111	111	111	111	111	131	111	111	MID PEAK	0.5
16a	1900-1945	111	111	111	111	004	111	121	111	111	MID LOW	0.75
17a	1945-2000	111	111	111	111	004	111	121	111	111	PM OFF 2	0.25
18a	2000-2100	111	111	111	111	004	111	121	121	121	PM OFF 2	1
1a	2100-2300	111	121	111	111	004	111	121	121	121	PM OFF 2	2

Existing TOD/Volume Case

CBD

Tab	Time	CSV	Volume Description	Base file	Hours/ day
1b	600-630	4	PM OFF 2	AM	0.50
2b	630-715	1	AM OFF	AM	0.75
3b	**715-845**	**1**	**AM PEAK**	**AM**	**1.50**
4b	845-900	5	AM OFF	OFF	0.25
5b	900-930	6	AM OFF	OFF	0.50
6b	930-1115	2	MID LOW	OFF	1.75
7b	**1115-1500**	**2**	**MID PEAK**	**OFF**	**3.75**
8b	1500-1545	7	PM OFF 1	PM	0.75
9b	*1545-1600*	*3*	*PM OFF 1*	*PM*	*0.25*
10b	**1600-1745**	**3**	**PM PEAK**	**PM**	**1.75**
9b	1745-1815	3	PM OFF 1	PM	0.50
11b	1815-1830	3	MID PEAK	PM	0.25
12b	1830-1900	8	MID PEAK	OFF	0.50
13b	1900-1945	8	MID LOW	OFF	0.75
14b	1945-2300	8	PM OFF 2	OFF	3.25

Volume/Time Check

CBD

Vol Case	Final	Existing	OK?
EARLY AM	0	0	OK
AM OFF	1.5	1.5	OK
AM PEAK	1.5	1.5	OK
MID LOW	2.5	2.5	OK
MID PEAK	4.5	4.5	OK
PM PEAK	1.75	1.75	OK
PM OFF 1	1.5	1.5	OK
PM OFF 2	3.75	3.75	OK
TOTAL	**17**	**17**	**OK**

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TRUCK PERCENTAGES

CBD

Average of 204 Intersections

Start Time	Mainline Volume (N/S) (Total)	Cross-Street Volume (E/W) (Total)	Mainline Volume (N/S) (Trucks)	Cross-Street Volume (E/W) (Trucks)	Mainline % Trucks	Cross-Street % Trucks
5:30 AM	1547	1517	189	163	12.2%	10.7%
5:45 AM	1979	1950	216	205	10.9%	10.5%
6:00 AM	2301	2226	296	227	12.9%	10.2%
6:15 AM	2990	3084	340	271	11.4%	8.8%
6:30 AM	4432	4216	507	389	11.4%	9.2%
6:45 AM	5557	5075	516	422	9.3%	8.3%
7:00 AM	21839	24702	2239	2271	10.3%	9.2%
7:15 AM	27139	30831	2561	2468	9.4%	8.0%
7:30 AM	32350	35558	2696	2431	8.3%	6.8%
7:45 AM	36532	39264	2819	2564	7.7%	6.5%
8:00 AM	35554	38684	2812	2561	7.9%	6.6%
8:15 AM	35301	38212	2759	2460	7.8%	6.4%
8:30 AM	32515	35979	2388	2244	7.3%	6.2%
8:45 AM	30560	33753	2409	2310	7.9%	6.8%
9:00 AM	6400	5833	422	417	6.6%	7.1%
9:15 AM	5779	5248	437	368	7.6%	7.0%
9:30 AM	5531	5110	481	346	8.7%	6.8%
9:45 AM	5249	5119	410	385	7.8%	7.5%
10:00 AM	4682	4369	409	346	8.7%	7.9%
10:15 AM	4552	4429	387	362	8.5%	8.2%
10:30 AM	4868	4499	382	326	7.8%	7.2%
10:45 AM	4944	4675	382	321	7.7%	6.9%
11:00 AM	5115	4655	363	332	7.1%	7.1%
11:15 AM	5182	4854	375	316	7.2%	6.5%
11:30 AM	21936	24291	1486	1502	6.8%	6.2%
11:45 AM	22485	24321	1483	1462	6.6%	6.0%
12:00 PM	21181	23529	1306	1408	6.2%	6.0%
12:15 PM	22234	24395	1371	1495	6.2%	6.1%
12:30 PM	23422	24786	1517	1468	6.5%	5.9%
12:45 PM	23407	25268	1548	1622	6.6%	6.4%
1:00 PM	23183	25099	1491	1566	6.4%	6.2%
1:15 PM	24131	25466	1622	1512	6.7%	5.9%
1:30 PM	5841	5341	375	346	6.4%	6.5%
1:45 PM	5607	5239	347	303	6.2%	5.8%
2:00 PM	5835	5602	375	404	6.4%	7.2%
2:15 PM	5731	5747	381	347	6.6%	6.0%
2:30 PM	6215	6156	413	411	6.6%	6.7%
2:45 PM	5888	5817	392	390	6.7%	6.7%
3:00 PM	6320	5940	456	392	7.2%	6.6%
3:15 PM	6494	6245	464	389	7.1%	6.2%
3:30 PM	7319	6910	511	457	7.0%	6.6%
3:45 PM	7403	6898	532	446	7.2%	6.5%
4:00 PM	33909	38034	2453	2345	7.2%	6.2%
4:15 PM	36144	39286	2568	2418	7.1%	6.2%
4:30 PM	39410	42882	2601	2439	6.6%	5.7%
4:45 PM	40671	44129	2496	2202	6.1%	5.0%
5:00 PM	41635	46040	2360	2058	5.7%	4.5%
5:15 PM	41956	46012	2078	1786	5.0%	3.9%
5:30 PM	38544	41879	1755	1533	4.6%	3.7%
5:45 PM	35020	37459	1547	1455	4.4%	3.9%
6:00 PM	7150	6330	296	251	4.1%	4.0%
6:15 PM	6524	5442	271	182	4.2%	3.3%
AM PEAK (715-845)	**199391**	**218528**	**16035**	**14728**	**8.0%**	**6.7%**
MID-DAY PEAK (1115-300)	**222278**	**240566**	**14845**	**14884**	**6.7%**	**6.2%**
PM PEAK (400-545)	**272269**	**324255**	**18274**	**16465**	**6.7%**	**5.1%**
OFF PERIODS (Remaining Hours)	**194555**	**195684**	**14462**	**13033**	**7.4%**	**6.7%**
	888493	**979033**	**63616**	**59110**	**7.2%**	**6.0%**
Off Peak (Mid + Off)	**416833**	**436250**	**29307**	**27917**	**7.0%**	**6.4%**

Cost per Stop Calculations

Table 2.3. Added time and vehicle running cost/1,000 stops and idling costs (Aug 96$)

Initial Speed (mph)	Added Cost ($/1,000 Stop) (Excludes idling time)		
	Pass Cars	Single-Unit Trucks	Combination Truck
5	2.70	9.25	33.62
10	8.83	20.72	77.49
15	15.16	33.89	129.97
20	21.74	48.40	190.06
25	**28.67**	**63.97**	**256.54**
30	36.10	80.23	328.21
35	44.06	96.88	403.84
40	52.70	113.97	482.21
45	62.07	130.08	562.14
50	72.31	145.96	642.41
55	83.47	160.89	721.77
60	95.70	178.98	798.99
65	109.02	195.84	NA*
70	123.61	NA*	NA*
75	139.53	NA*	NA*
80	156.85	NA*	NA*

* Original data did not provide values for trucks at higher speeds.

Source: Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA, September 1998

Weighted Average Vehicle Fleet Percentages (Total Project)

	Pass Cars (10-Hr Total)	Single-Unit Trucks (10-Hr Total)	Combination Truck (10-Hr Total)	% Pass Cars	% Single-Unit	% Combination Truck
CBD	1,867,526	110,453	12,273	93.8%	5.5%	0.6%
Project Total	**1,867,526**	**110,453**	**12,273**	**93.4%**	**5.9%**	**0.7%**

Reference: "Trucks" excel tab

Note: Single Unit Trucks assumed to represent 90% of the Truck Fleet

Weighted Average Cost per Stop (Total Project)

Average Cost per Stop - Network Average	**$0.032**

Measures of Effectiveness Summary

	Aggregate Timing Plans[2]	MOE - Net Reduction from Existing to Proposed Condition[1]							
		Stops (no. of veh) (All Approaches)	Delay (veh-hr) (North/South Streets)	Delay (veh-hr) (East/West Streets)	Passenger Delay (hr)[3]	Fuel Consumption (gal) (All Approaches)	Emissions CO (kg) (All Approaches)	Emissions NOx (kg) (All Approaches)	Emissions VOC (kg) (All Approaches)
Minneapolis - Downtown Signals	AM Peak Period (715 AM to 845 AM)	66,146	129.6	295.6	94.4	433	44.9	7.8	6.6
	Off Peak Periods (Remaining Daily Hours)	260,542	433.7	767.6	622.5	1767	143.7	26.0	27.1
	PM Peak Period (400 PM to 545 PM)	77,494	300.2	525.5	253.8	531	52.9	7.8	6.5
	LRT Passenger Delay (Daily)	N/A	N/A	N/A	145.4	N/A	N/A	N/A	N/A
	Marquette/2nd Ave Passenger Delay (AM/PM Peak Hour)	N/A	N/A	N/A	135.7	N/A	N/A	N/A	N/A
	Weekend Daily	205,926	291.6	584.9	38.8	1590	101.9	20.0	24.4
	Subtotal Downtown Signals	**610,107**	**1155**	**2174**	**1291**	**4321**	**343.4**	**61.6**	**64.6**

[1] A positive value equals the net reduction (i.e., benefit) and a negative value equals a net increase (i.e., impact)

[2] Off peak period includes the AM OFF, MID PEAK, MID LOW, PM OFF 1, and PM OFF 2 Plans.

[3] Passenger delay for LRT and Marquette/2nd Ave calculated using VISSIM for AM and PM peak periods.

Unit Benefit

Motorist User Costs

MOE	Unit Price
Value of Time - Truck[1]	$27.20
Value of Time - Auto[1]	$15.00
Vehicle Stop[2]	$0.032
Fuel Cost[3]	$3.51

[1] Mn/DOT Office of Investment Management Benefit-Cost Analysis
for Transportation Projects, Appendix A, Table A.1, SFY2014
Recommended Standard Values

[2] Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA,
Table 2.3 (Vehicle Cost per Stop), September 1998 (Refer to Appendix D for calculations)

[3] US Department of Engergy, Engergy Information Administration,
Average Fuel Prices 12/01/12 to 11/30/13

Air Pollutant Damage Costs and Adjustment Factors Used in HERS

Pollutant	Damage Costs ($/ton)	Urban Adjustment Factor
Carbon Monoxide (CO)	100	1
Volatile Organic Compounds (VOC)	2750	1.5
Nitrogen Oxides (NOx)	3625	1.5

HERS-ST 2.0 (Highway Economic Requirements System – State Version) Technical Reports, U.S. Department of Transportation/Federal Highway Administration, 2002.
Table E5 - "Air Pollution Damage Costs and Adjustment Factors Used in HERS."
Costs converted from Year 2000 to Year 2009 by Consumer Price Index of 1.25.

Total Project Benefit

	Aggregate Timing Plans[3]	Truck Percent (N/S)	Truck Percent (E/W)	Occ.[1]	Days/ Year[2]	Value of Time Benefit ($) (North/South Streets)	Value of Time Impact ($) (East/West Streets)	Value of Time Impact ($) (Passengers)	Stops Reduction Benefit ($)	Fuel Reduction Benefit ($)	Emission Reduction Benefit ($)	Total Benefit ($)
Minneapolis - Downtown Signals	AM Peak Period (715 AM to 845 AM)	8.0%	6.7%	1.30	251	$654,544	$1,485,255	$355,571	$535,519	$381,389	$18,631	$3,430,910
	Off Peak Periods (Remaining Daily Hours)	7.0%	6.4%	1.30	251	$2,181,729	$3,851,908	$2,343,830	$2,109,362	$1,556,635	$67,126	$12,110,590
	PM Peak Period (400 PM to 545 PM)	6.7%	5.1%	1.30	251	$1,508,429	$2,623,526	$955,682	$627,393	$468,081	$18,686	$6,201,795
	LRT Passenger Delay	0.0%	0.0%	(4)	251	N/A	N/A	$547,559	N/A	N/A	N/A	$547,559
	Marquette/2nd Ave Passenger Delay	7.2%	6.0%	(5)	251	N/A	N/A	$510,804	N/A	N/A	N/A	$510,804
	Weekday Daily	7.2%	6.0%	1.30	251	$4,344,702	$7,960,689	$4,713,447	$3,272,274	$2,406,104	$104,443	$22,801,659
	Weekend Daily	1.0%	1.0%	1.30	104	$593,641	$1,190,811	$60,552	$690,788	$580,414	$22,837	$3,139,044
	Subtotal (Annual Total Benefit)					**$4,938,343**	**$9,151,500**	**$4,773,999**	**$3,963,062**	**$2,986,518**	**$127,281**	**$25,940,703**
	Total Project - Minneapolis CBD (Average Annual Benefit)					**$4,938,343**	**$9,151,500**	**$4,773,999**	**$3,963,062**	**$2,986,518**	**$127,281**	**$25,940,703**

[1] 2010 Metropolitan Council Travel Behavior Inventory (TBI) Home Interview Survey

[2] Total weekday days were reduced by 10 to account for Holidays.

[3] Off peak period includes the AM OFF, MID PEAK, MID LOW, PM OFF 1, and PM OFF 2 Plans.

[4] Based on LRT station to station ridership data provided by Metro Transit in 2011

[5] Assumes a constant average bus occupancy of 30 passengers.

Total Estimated Project Costs

Cost Description	Unit Cost
Alliant Eng. Consultant Contract	$525,000.00
Agency Staff Time[1]	$0.00
Equipment	$0.00
	$525,000.00

[1] Assumes agency labor rate of $60 per hour

Benefit-Cost Ratio

Segment	Number of Intersections	Cost ($)	Benefit ($)	Benefit-Cost Ratio
Minneapolis Downtown CBD	205	$525,000	$25,940,703	**49**

Traffic Volume Cases and TOD Signal Timing Plans --- WEEKEND

Final TOD/Volume Case

CBD

Tab	Time	Group 1 Henn, 1st, 2nd	Group 2 Henn/Lyn	Group 3: CBD Core	Group 4: Wash	Group 5: W end of 5th St	Group 6: W end of 12th St	Group 7: Cedar/River	Group 8: Henn, 1st 2nd	Group 9: Dunwoody/Colfax	Volume Description	Hours/ day
1a	600-900	111	121	111	111	004	111	121	121	121	PM OFF 2	3
30a	900-1100	111	111	111	111	111	111	121	121	121	PM OFF 2	2
31a	1100-1700	111	111	111	111	111	111	131	121	121	MID LOW	6
32a	1700-1900	111	111	111	111	111	111	121	111	121	PM OFF 2	2
33a	1900-2100	111	111	111	111	004	111	121	111	121	PM OFF 2	2
1a	2100-2300	111	121	111	111	004	111	121	121	121	PM OFF 2	2

Existing TOD/Volume Case

CBD

Tab	Time	CSV	Volume Description	Base file	Hours/ day
14b	600-900	8	PM OFF 2	OFF	3
30b	900-1100	2	PM OFF 2	OFF	2
31b	1100-1700	2	MID LOW	OFF	6
30b	1700-2100	2	PM OFF 2	OFF	4
14b	2100-2300	8	PM OFF 2	OFF	2

Volume/Time Check

CBD

Vol Case	Final	Existing	OK?
EARLY AM	0	0	OK
AM OFF	0	0	OK
AM PEAK	0	0	OK
MID LOW	6	6	OK
MID PEAK	0	0	OK
PM PEAK	0	0	OK
PM OFF 2	11	11	OK
OVERNIGHT	0	0	OK
TOTAL	**17**	**17**	**OK**

X:\2011\110022\COST BENEFIT\[CBD_Cost Benefit Analysis_Saturday.xlsx]TOD_VOL CASES

LRT PASSENGER DELAY AND RIDERSHIP CALCULATIONS --- WEEKDAY

	Segment	Existing ("Before") AM Peak	Existing ("Before") OFF Peak	Existing ("Before") PM Peak	Implemented ("After") AM Peak	Implemented ("After") OFF Peak	Implemented ("After") PM Peak	Percent Reduction AM Peak	Percent Reduction Mid-Day Peak	Percent Reduction PM Peak
5th Street LRT Delay per trip (seconds)	Downtown East Station to Government Plaza Station	44	111	67	21	75	29	113%	48%	131%
	Government Plaza Station to Nicollet Mall Station	27	83	77	24	72	16	15%	16%	374%
	Nicollet Mall Station to Hennepin Avenue Station	18	44	32	21	38	58	-16%	14%	-45%
	Hennepin Avenue Station to Target Field Station	59	57	57	57	65	69	4%	-12%	-17%
	NB Total	148	296	233	122	251	173	22%	18%	35%
	Target Field Station to Hennepin Avenue Station	91	68	99	54	61	49	69%	12%	103%
	Hennepin Avenue Station to Nicollet Mall Station	57	38	30	21	20	26	171%	92%	16%
	Nicollet Mall Station to Government Plaza Station	107	34	40	50	48	51	113%	-29%	-22%
	Government Plaza Station to Downtown East Station	60	62	54	27	58	23	120%	8%	131%
	SB Total	314	202	223	152	186	149	107%	9%	50%

AM Peak: 700 to 900 AM
OFF Peak: Remaining weekday hours
PM Peak: 300 PM to 600 PM

Weekday Analysis

	Existing ("Before") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
Downtown East Station to Government Plaza Station	111	111	111	44	44	111	111	111	111	111	111	67	67	67	111	111	111	111	111
Government Plaza Station to Nicollet Mall Station	83	83	83	27	27	83	83	83	83	83	83	77	77	77	83	83	83	83	83
Nicollet Mall Station to Hennepin Avenue Station	44	44	44	18	18	44	44	44	44	44	44	32	32	32	44	44	44	44	44
Hennepin Avenue Station to Target Field Station	57	57	57	59	59	57	57	57	57	57	57	57	57	57	57	57	57	57	57
NB Total	296	296	296	148	148	296	296	296	296	296	296	233	233	233	296	296	296	296	296
Target Field Station to Hennepin Avenue Station	68	68	68	91	91	68	68	68	68	68	68	99	99	99	68	68	68	68	68
Hennepin Avenue Station to Nicollet Mall Station	38	38	38	57	57	38	38	38	38	38	38	30	30	30	38	38	38	38	38
Nicollet Mall Station to Government Plaza Station	34	34	34	107	107	34	34	34	34	34	34	40	40	40	34	34	34	34	34
Government Plaza Station to Downtown East Station	62	62	62	60	60	62	62	62	62	62	62	54	54	54	62	62	62	62	62
SB Total	202	202	202	314	314	202	202	202	202	202	202	223	223	223	202	202	202	202	202

Weekday Analysis

	Implemented ("After") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
Downtown East Station to Government Plaza Station	75	75	75	21	21	75	75	75	75	75	75	29	29	29	75	75	75	75	75
Government Plaza Station to Nicollet Mall Station	72	72	72	24	24	72	72	72	72	72	72	16	16	16	72	72	72	72	72
Nicollet Mall Station to Hennepin Avenue Station	38	38	38	21	21	38	38	38	38	38	38	58	58	58	38	38	38	38	38
Hennepin Avenue Station to Target Field Station	65	65	65	57	57	65	65	65	65	65	65	69	69	69	65	65	65	65	65
NB Total	251	251	251	122	122	251	251	251	251	251	251	173	173	173	251	251	251	251	251
Target Field Station to Hennepin Avenue Station	61	61	61	54	54	61	61	61	61	61	61	49	49	49	61	61	61	61	61
Hennepin Avenue Station to Nicollet Mall Station	20	20	20	21	21	20	20	20	20	20	20	26	26	26	20	20	20	20	20
Nicollet Mall Station to Government Plaza Station	48	48	48	50	50	48	48	48	48	48	48	51	51	51	48	48	48	48	48
Government Plaza Station to Downtown East Station	58	58	58	27	27	58	58	58	58	58	58	23	23	23	58	58	58	58	58
SB Total	186	186	186	152	152	186	186	186	186	186	186	149	149	149	186	186	186	186	186

	Existing ("Before") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
NB Number of trips	7	6	7	7	6	7													
NB DTE to GOVT	152	49	127	152	49	127													
NB GOVT to NIC	139	39	90	139	39	90													
NB NIC to WARE	81	14	23	81	14	23													
NB WARE to TF	55	4	3	55	4	3													
SB Number of trips	6	6	7	6	6	7													
SB TF to WARE	23	5	5	23	5	5													
SB WARE to NIC	34	18	34	34	18	34													
SB NIC to GOVT	59	52	134	59	52	134													
SB GOVT to DTE	64	65	189	64	65	189													

	Implemented ("After") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
NB Number of trips	**4**	**6**	**6**	**6**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**7**	**6**	**6**	**7**	**5**	**4**	**5**	**10**
NB DTE to GOVT	13	44	73	161	72	66	41	59	50	45	62	83	139	79	67	59	34	32	56
NB GOVT to NIC	10	42	66	145	61	53	32	48	44	34	52	63	103	58	46	48	31	46	17
NB NIC to WARE	6	22	52	93	25	20	13	21	17	13	20	20	30	17	16	17	15	30	10
NB WARE to TF	3	11	35	67	7	5	4	3	4	3	6	3	4	4	4	3	2	5	2
SB Number of trips	**3**	**5**	**7**	**6**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**7**	**5**	**4**	**4**	**4**	**6**
SB TF to WARE	2	6	20	26	4	3	3	3	5	4	7	4	5	8	6	3	2	5	2
SB WARE to NIC	4	12	30	36	14	12	11	19	22	18	24	24	35	31	25	20	16	32	11
SB NIC to GOVT	7	23	38	56	35	32	27	44	58	47	61	77	120	107	73	58	34	48	19
SB GOVT to DTE	9	24	42	62	41	40	35	54	67	62	73	102	161	145	107	70	37	34	63

	MOE	Existing ("Before") AM Peak	Existing ("Before") OFF Peak	Existing ("Before") PM Peak	Implemented ("After") AM Peak	Implemented ("After") OFF Peak	Implemented ("After") PM Peak	Total Change AM Peak	Total Change OFF Peak	Total Change PM Peak
5th Street LRT Person-Hour Delay	Downtown East Station to Government Plaza Station	18.0	133.3	35.4	8.4	90.2	15.3	9.6	43.2	20.0
	Government Plaza Station to Nicollet Mall Station	9.8	77.6	30.0	8.5	66.7	6.3	1.3	10.9	23.7
	Nicollet Mall Station to Hennepin Avenue Station	3.6	19.4	3.8	4.2	17.0	6.8	-0.7	2.4	-3.1
	Hennepin Avenue Station to Target Field Station	7.4	8.5	1.1	7.1	9.7	1.3	0.3	-1.2	-0.2
	NB Total	38.7	238.8	70.2	28.2	183.6	29.8	10.5	55.2	40.4
	Target Field Station to Hennepin Avenue Station	4.6	7.8	3.0	2.7	6.9	1.5	1.9	0.8	1.5
	Hennepin Avenue Station to Nicollet Mall Station	4.9	14.4	4.7	1.8	7.5	4.1	3.1	6.9	0.6
	Nicollet Mall Station to Government Plaza Station	17.2	28.7	21.4	8.1	40.4	27.3	9.1	-11.6	-5.9
	Government Plaza Station to Downtown East Station	11.0	67.3	39.0	5.0	62.5	16.9	6.0	4.7	22.1
	SB Total	37.7	118.2	68.2	17.6	117.4	49.8	20.1	0.8	18.4

AM Peak: 700 to 900 AM
OFF Peak: Remaining weekday hours
PM Peak: 300 PM to 600 PM

	Existing ("Before") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
Downtown East Station to Government Plaza Station	1.6	8.2	13.5	11.8	6.2	12.2	7.6	10.9	9.3	8.3	11.5	10.9	15.6	8.9	14.5	9.1	4.2	4.9	17.3
Government Plaza Station to Nicollet Mall Station	0.9	5.8	9.2	6.6	3.2	7.4	4.4	6.7	6.1	4.7	7.2	9.4	13.2	7.4	7.5	5.6	2.9	5.3	3.9
Nicollet Mall Station to Hennepin Avenue Station	0.3	1.6	3.8	2.7	0.9	1.5	0.9	1.5	1.2	0.9	1.5	1.3	1.6	0.9	1.4	1.0	0.7	1.8	1.2
Hennepin Avenue Station to Target Field Station	0.2	1.1	3.4	6.6	0.8	0.5	0.4	0.3	0.4	0.3	0.6	0.3	0.4	0.4	0.4	0.2	0.1	0.4	0.3
NB Total	3.0	16.6	29.8	27.7	11.0	21.5	13.4	19.4	17.0	14.3	20.8	21.9	30.8	17.6	23.8	15.9	7.9	12.5	22.8
Target Field Station to Hennepin Avenue Station	0.1	0.6	2.7	3.9	0.7	0.3	0.3	0.3	0.6	0.5	0.8	0.7	0.8	1.5	0.6	0.2	0.2	0.4	0.2
Hennepin Avenue Station to Nicollet Mall Station	0.1	0.6	2.2	3.4	1.5	0.8	0.7	1.2	1.4	1.1	1.5	1.2	1.7	1.8	1.3	0.8	0.7	1.3	0.7
Nicollet Mall Station to Government Plaza Station	0.2	1.1	2.5	9.9	7.3	1.8	1.5	2.5	3.3	2.7	3.4	5.1	8.0	8.3	3.4	2.2	1.3	1.8	1.1
Government Plaza Station to Downtown East Station	0.5	2.1	5.1	6.2	4.8	4.1	3.6	5.6	6.9	6.4	7.5	9.2	14.5	15.3	9.2	4.8	2.6	2.3	6.5
SB Total	0.9	4.3	12.4	23.5	14.3	7.0	6.2	9.6	12.2	10.6	13.3	16.2	25.1	26.9	14.5	8.1	4.7	5.9	8.5

	Implemented ("After") 4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23
Downtown East Station to Government Plaza Station	1.1	5.5	9.2	5.5	2.9	8.3	5.1	7.4	6.3	5.6	7.8	4.7	6.8	3.8	9.8	6.2	2.8	3.3	11.7
Government Plaza Station to Nicollet Mall Station	0.8	5.0	7.9	5.7	2.8	6.3	3.8	5.7	5.3	4.1	6.2	2.0	2.8	1.6	6.4	4.8	2.5	4.6	3.4
Nicollet Mall Station to Hennepin Avenue Station	0.3	1.4	3.3	3.2	1.0	1.3	0.8	1.3	1.1	0.8	1.3	2.3	2.9	1.7	1.2	0.9	0.6	1.6	1.1
Hennepin Avenue Station to Target Field Station	0.2	1.2	3.8	6.3	0.8	0.5	0.4	0.3	0.4	0.3	0.7	0.4	0.5	0.5	0.5	0.3	0.1	0.5	0.4
NB Total	2.4	13.1	24.2	20.8	7.5	16.4	10.2	14.8	13.0	10.9	15.9	9.4	12.9	7.5	17.9	12.1	6.1	10.0	16.5
Target Field Station to Hennepin Avenue Station	0.1	0.5	2.4	2.3	0.4	0.3	0.3	0.3	0.5	0.4	0.7	0.3	0.4	0.8	0.5	0.2	0.1	0.3	0.2
Hennepin Avenue Station to Nicollet Mall Station	0.1	0.3	1.1	1.3	0.6	0.4	0.4	0.6	0.7	0.6	0.8	1.0	1.5	1.6	0.7	0.4	0.3	0.7	0.4
Nicollet Mall Station to Government Plaza Station	0.3	1.5	3.5	4.7	3.4	2.5	2.1	3.5	4.6	3.7	4.8	6.5	10.2	10.6	4.8	3.1	1.8	2.5	1.5
Government Plaza Station to Downtown East Station	0.4	1.9	4.7	2.8	2.2	3.8	3.4	5.2	6.4	6.0	7.0	4.0	6.3	6.6	8.6	4.5	2.4	2.2	6.1
SB Total	0.9	4.3	11.8	11.1	6.6	7.1	6.2	9.6	12.3	10.7	13.4	11.9	18.4	19.5	14.6	8.2	4.7	5.8	8.1

	MOE	Existing ("Before") AM Peak	Existing ("Before") Mid-Day Peak	Existing ("Before") PM Peak	Implemented ("After") AM Peak	Implemented ("After") Mid-Day Peak	Implemented ("After") PM Peak	Percent Reduction AM Peak	Percent Reduction Mid-Day Peak	Percent Reduction PM Peak
5th Street LRT	**Total Delay (person-hr)**	76	357	138	46	301	80	66.7%	18.6%	73.8%

AM Peak: 700 to 900 AM
OFF Peak: Remaining weekday hours
PM Peak: 300 PM to 600 PM

LRT PASSENGER DELAY AND RIDERSHIP CALCULATIONS --- WEEKEND

	Segment	Existing ("Before") Weekend	Implemented ("After") Weekend	Percent Reduction Weekend
5th Street LRT Delay per trip (seconds)	Downtown East Station to Government Plaza Station	111	**75**	**48%**
	Government Plaza Station to Nicollet Mall Station	83	**72**	**16%**
	Nicollet Mall Station to Hennepin Avenue Station	44	**38**	**14%**
	Hennepin Avenue Station to Target Field Station	57	**65**	**-12%**
	NB Total	296	**251**	**18%**
	Target Field Station to Hennepin Avenue Station	68	**61**	**12%**
	Hennepin Avenue Station to Nicollet Mall Station	38	**20**	**92%**
	Nicollet Mall Station to Government Plaza Station	34	**48**	**-29%**
	Government Plaza Station to Downtown East Station	62	**58**	**8%**
	SB Total	202	**186**	**9%**

Weekend Analysis

Existing ("Before")						
4 to 6	6 to 9	9 to 3	3 to 7	7 to 10	10 to 3	
111	111	111	111	111	111	
83	83	83	83	83	83	
44	44	44	44	44	44	
57	57	57	57	57	57	
296	296	296	296	296	296	
68	68	68	68	68	68	
38	38	38	38	38	38	
34	34	34	34	34	34	
62	62	62	62	62	62	
202	202	202	202	202	202	

Weekend Analysis

Implemented ("After")						
4 to 6	6 to 9	9 to 3	3 to 7	7 to 10	10 to 3	
75	75	75	75	75	75	
72	72	72	72	72	72	
38	38	38	38	38	38	
65	65	65	65	65	65	
251	251	251	251	251	251	
61	61	61	61	61	61	
20	20	20	20	20	20	
48	48	48	48	48	48	
58	58	58	58	58	58	
186	186	186	186	186	186	

NB Number of trips	**NB Number of trips**	**7**	**12**	**36**	**24**	**13**	**11**	**7**	**12**	**36**	**24**	**13**	**11**
NB DTE to GOVT	NB DTE to GOVT	14	16	29	32	25	41	14	16	29	32	25	41
NB GOVT to NIC	NB GOVT to NIC	12	11	24	24	22	39	12	11	24	24	22	39
NB NIC to WARE	NB NIC to WARE	7	6	9	9	12	35	7	6	9	9	12	35
NB WARE to TF	NB WARE to TF	2	1	2	2	2	1	2	1	2	2	2	1
SB Number of trips	**SB Number of trips**	**6**	**12**	**36**	**22**	**12**	**7**	**6**	**12**	**36**	**22**	**12**	**7**
SB TF to WARE	SB TF to WARE	2	1	3	2	1	2	2	1	3	2	1	2
SB WARE to NIC	SB WARE to NIC	8	7	15	9	7	47	8	7	15	9	7	47
SB NIC to GOVT	SB NIC to GOVT	12	13	38	25	13	53	12	13	38	25	13	53
SB GOVT to DTE	SB GOVT to DTE	15	18	46	34	14	56	15	18	46	34	14	56

	MOE	Existing ("Before") Weekend	Implemented ("After") Weekend	Percent Reduction Weekend
5th Street LRT Person-Hour Delay	Downtown East Station to Government Plaza Station	89.64	**60.62**	**29.0**
	Government Plaza Station to Nicollet Mall Station	54.78	**47.11**	**7.7**
	Nicollet Mall Station to Hennepin Avenue Station	14.76	**12.96**	**1.8**
	Hennepin Avenue Station to Target Field Station	2.80	**3.19**	**-0.4**
	NB Total	161.98	**123.88**	**38.1**
	Target Field Station to Hennepin Avenue Station	3.90	**3.50**	**0.4**
	Hennepin Avenue Station to Nicollet Mall Station	13.48	**7.01**	**6.5**
	Nicollet Mall Station to Government Plaza Station	25.08	**35.25**	**-10.2**
	Government Plaza Station to Downtown East Station	56.72	**52.72**	**4.0**
	SB Total	99.18	**98.47**	**0.7**

Existing ("Before")						
4 to 6	6 to 9	9 to 3	3 to 7	7 to 10	10 to 3	
3.13	5.92	32.68	23.98	9.91	14.02	
1.91	3.11	19.89	13.33	6.55	9.98	
0.63	0.90	4.12	2.56	1.91	4.64	
0.22	0.14	1.18	0.74	0.32	0.21	
5.88	10.07	57.87	40.62	18.68	28.86	
0.23	0.19	2.22	0.85	0.20	0.22	
0.48	0.90	5.62	2.12	0.89	3.47	
0.68	1.47	12.79	5.20	1.43	3.51	
1.53	3.82	28.81	12.82	2.97	6.77	
2.92	6.37	49.44	20.98	5.49	13.97	

Implemented ("After")						
4 to 6	6 to 9	9 to 3	3 to 7	7 to 10	10 to 3	
2.11	4.01	22.10	16.22	6.70	9.48	
1.64	2.68	17.11	11.46	5.63	8.59	
0.56	0.79	3.62	2.25	1.68	4.08	
0.24	0.15	1.34	0.84	0.36	0.24	
4.56	7.62	44.16	30.78	14.37	22.39	
0.20	0.17	1.99	0.76	0.18	0.19	
0.25	0.47	2.93	1.10	0.46	1.80	
0.96	2.06	17.97	7.30	2.01	4.94	
1.42	3.55	26.78	11.91	2.76	6.29	
2.84	6.25	49.66	21.08	5.42	13.23	

	MOE	Existing ("Before") Weekend	Implemented ("After") Weekend	Percent Reduction Weekend
5th Street LRT				
	Total Delay (person-hr)	261	222	**17.5%**